Alameda Watershed Management Plan

APPENDIX A
VOLUME II

San Francisco Public Utilities Commission

November 1998

List of Appendices

The following documents and memoranda were prepared during the course of the watershed management planning process. This information was gathered at specific points in time during the planning process and does not necessarily represent the information contained in the Alameda Watershed Management Plan. Some specific issues noted in the following appendices may have been refined through the planning process. These refinements are reflected in the Alameda Watershed Management Plan.

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[1] *Material in this Appendix has been prepared exclusively for the Alameda Watershed.*

[2] *Material in this Appendix covers both the Peninsula and Alameda Watersheds, and therefore it is a common Appendix to both the Peninsula Watershed Management Plan and the Alameda Watershed Management Plan.*

[3] *The Sunol Valley Resources Management Element Draft Public Involvement Summary Report (August 1995) is included in the Sunol Valley Resources Management Element, Appendix A-3.*

Appendix A-4

Alameda Watershed Natural and Cultural Resources
June 1994

ALAMEDA WATERSHED

Natural and Cultural Resources

June 1994

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SAN FRANCISCO WATERSHED MANAGEMENT PLAN
ALAMEDA WATERSHED RESOURCES

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1.0 GEOLOGIC RESOURCES

REGIONAL OVERVIEW

The Alameda watershed is located along the western flank of the northern Diablo Range, within California's geologically complex and seismically active Coast Ranges geomorphic province. The Coast Ranges province is characterized by a series of northwest-trending faults, mountain ranges, and valleys. The Diablo Range, which forms the eastern boundary of the Coast Ranges, separates the structural trough encompassing San Francisco Bay and Santa Clara Valley (to the west) from the San Joaquin Valley (to the east).

The geology of the Alameda watershed is dominated by the presence of the Calaveras fault zone. The fault zone created the rift valley in which Calaveras Reservoir is located, and separates the watershed into halves with markedly different geologic formations and structures. The Calaveras fault zone trends northwest through the length of the watershed, passing through the center of Calaveras Reservoir and traversing the eastern margin of Sunol Valley (coincident with Calaveras Road).

RESOURCE DESCRIPTION

Several maps provide information on the distribution of geologic resources within the Alameda Watershed: Figure 1-1 shows the geologic formations and associated faults that underlay the watershed; Figure 1-2 shows the soil units; Figure 1-3 shows the mineral resources zones and prime farmland soils; and Figure 1-4 shows the major landslide areas. These resources are discussed from a watershed-wide perspective below, and then presented more specifically by watershed sub-basin in the Drainage Basin Descriptions at the end of this section.

Topography

The topography of the Alameda Watershed consists of a major northwest-trending rift valley along the Calaveras fault (Calaveras Creek and Sunol Valley, and the northern extension to Amador Valley), a major east-west valley (La Costa Valley and San Antonio Creek valley), and rugged terrain surrounding the major valleys. Elevations in the watershed range from a low of about 230 feet above mean sea level (msl) at the northern end of Sunol Valley to a high of about 3,300 feet above msl in the extreme southeastern corner of the watershed. Slopes in the upland areas are steep to very steep, with average gradients ranging from about 3:1 (horizontal to vertical ratio) to 1:1. In stark contrast, the major valleys have nearly level floors of alluvial fill.

Most of the tributary stream valleys are very narrow, with "V" shaped cross sections, lacking significant alluvial floodplain or terrace deposits.

Geology and Faults

The northern segment of the Calaveras fault dominates the seismic setting of the watershed, along with other active regional faults including the Hayward and San Andreas faults. In addition, several faults that may have experienced Late Quaternary and Holocene displacement are also within and adjacent to the SFWD Alameda watershed. The major active regional faults, and potentially active local faults that may generate seismic activity affecting the watershed are listed in Table A.1.

The Calaveras fault zone is a major structural feature of this part of California, associated with the larger system of lateral faults comprising the San Andreas fault zone (California DWR, 1974). The northern Calaveras fault zone extends from Calaveras Reservoir on the south to the vicinity of Walnut Creek on the north. Simpson and others (1992) have developed a segmentation model of the northern Calaveras Fault, and have identified four segments north of Calaveras Reservoir based on geomorphic expression, fault geometry, seismicity, intersecting structures, and range front orientation. The Calaveras Reservoir, Sunol, and San Ramon segments are within the SFWD boundaries.

In the study area, the Calaveras Fault extends along the western side of the Arroyo de la Laguna canyon to the Sunol Valley, along the eastern margin of the valley. Within this segment, the location of the fault is obscured due to poor geomorphic expression and concealment by large late Quaternary landslides. In addition, little is known about the rate and distribution of geologic sip, or about the northern end of the segment and its association with the Concord fault to the northeast and Hayward fault to the west. Due to this lack of data, the northern Calaveras Fault zone is the most prominent, potentially hazardous fault within the Bay region for which insufficient information is available for reliable earthquake hazard analysis (WGCEP, 1990; Simpson, and others, 1992).

The Calaveras fault zone marks the boundary between two major stratigraphic sequences. The fault zone separates the Hayward Hills (to the west), where basement rocks consist of Cretaceous (about 65 to 135 million years old) sedimentary rocks of the Great Valley sequence, from the Diablo Range (to the east), where basement rocks consist of sedimentary and metamorphic rocks of the Jurassic (135 to 190 million years old) to Cretaceous Franciscan complex. Within the watershed, Tertiary (about 2.5 to 65 million years old) marine deposits overlie both of these units, along with Quaternary alluvium and colluvium to various depths.

TABLE 1-1: FAULTS IN THE VICINITY OF THE ALAMEDA WATERSHED

Fault Zone	Relative Location	Recency of Faulting /a/	Historical Seismicity /b/	Maximum Credible Earthquake (MCE) /c/
(northern) Calaveras	within watershed	Historic, Holocene, Late Quaternary	M5.6-M6.4; 1861* M4 to 4.5 swarms 1970, 1990	7.5
(central) Calaveras	south of Calaveras Reservoir	Historic, Holocene, Late Quaternary	M 6.1; 1984 M 5.9; 1979 1861 Many <M 6.5	7.5
Hayward	3 miles southwest	Historic, Holocene	M 6.8; 1868 M 7.0; 1838 Many <M 4.5	7.5
San Andreas	20 miles west	Historic, Holocene	M 7.1; 1989 M 8.25;1906 M 7.0; 1838 Many <M 6	8
Greenville	8 miles northeast	Historic, Holocene	M 5.6; 1980	7.25
Las Positos	less than 1 mile north	Holocene, Late Quaternary	minor slip with 1980 Greenville	na
Williams Fault	within watershed	Late Quaternary		na
Verona Fault	less than 1 mile north	Holocene		na
Mission Fault	within watershed	Quaternary		na

/a/ Recency of faulting based on Jennings, 1992. Historic: displacement during historic time (within last 200 years), including areas of known fault creep; Holocene: evidence of displacement during the last 10,000 years; Quaternary; evidence of displacement during the last 1.6 million years; Pre-Quaternary: no recognized displacement during the last 1.6 million years (but not necessarily inactive).

/b/ Richter magnitude (M) and year for recent and /or large events.

/c/ The MCE is an estimated Richter scale magnitude for the largest earthquake that appears capable of occurring on a fault, based on empirical relationships between fault length, fault rupture length, and historic earthquake magnitudes. MCE as reported in: Mualchin, L. and A.L. Jones, 1992.

NOTES:

* Simpson and others, 1992.

na = Not applicable and/or not available.

SOURCES: Jennings, C.W. 1992, Preliminary Fault Activity map of California (with Appendix), California Division of Mines and Geology, Open-File Report 92-03; Mualchin, L. and A.L. Jones, 1992, Peak Acceleration from Maximum Credible Earthquakes in California (rock and stiff soil sites), California Division of Mines and Geology. Open-File Report 92-1.

The Franciscan complex consists primarily of graywacke (dark, impure sandstone), but also includes shale, chert, basalt, and schist. The Franciscan complex rocks are typically highly deformed and sheared. The Franciscan complex is thought to represent a tectonic assemblage composed of tectonically emplaced belts with distinctive and varying lithologies and widely ranging ages. Serpentine, an alteration product of ultramafic rocks (those containing high concentrations of magnesium and iron), is commonly associated with the Franciscan complex, appearing as intrusions or along shear zones and faults.

Surficial deposits include Quaternary (less than 2.5 million years old) alluvial (stream) and landslide deposits. The alluvial deposits include older stream terrace deposits as well as active stream channel deposits. They consist of poorly sorted stream deposits derived from local sources. The alluvial deposits are most extensive in the Sunol, La Costa, and Amador Valleys. They are an important source of aggregate mineral resources, and include large areas of prime farmland soils.

Mineral Resources

Two active sand and gravel quarries are located within the Alameda Watershed in Sunol Valley: the Mission Valley Rock and Lone Star Quarries. A crushed stone quarry has been proposed on Apperson Ridge (to the east of the watershed boundary). This quarry has received an 80-year permit; operations are expected to begin when they become economically viable.

The California Division of Mines and Geology (CDMG) has classified lands within the San Francisco-Monterey Bay region into Mineral Resource Zones (MRZs), based on guidelines adopted by the California State Mining and Geology Board, as mandated by the Surface Mining and Reclamation Act (SMARA) of 1975 (Stinson et al. 1983). Given the historical production within SFWD lands, the watershed was included in the DMG classification for aggregated resources. No assessment of non-aggregate mineral resources has been made in the vicinity, and no recent commercial or exploratory mining activities suggest that significant resources occur.

Slope Stability

Landslides are common in the vicinity, and are pervasive throughout many of the upland areas within the watershed (Nilsen 1972, 1973). The regional assessment of slope stability by Nielsen and others (1979) rates most of the upland watershed areas as unstable (Category 5) and moderately unstable (Category 4) lands. The only portions of the Alameda watershed rated as stable (Category 1) or generally stable (Category 2) are the flat valley floors and nearly level older alluvial terraces on their margins (Nilsen, et al., 1979).

Soils

The soils in the watershed generally reflect the underlying geology, with variations related to slope position and stability. In areas underlain by sedimentary rocks, the soils generally consist of the Millsholm-Los Gatos-Los Osos association; in areas underlain by rocks of the Franciscan complex, soils generally consist of the Vallecitos-Parish association (SCS 1966, 1968). Soils of both these associations are upland soils, and are generally well drained to excessively drained, shallow to moderately deep, and moderately eroded. Soils of the Yolo-Pleasanton association have developed on the alluvial deposits. These soils are generally well-drained, very deep, and have low potential for erosion.

Accelerated erosion in this region has occurred historically through both sheet erosion and gully erosion. Sheet erosion, the removal of soil more or less uniformly in a thin layer, is more damaging and less obvious that gullying. Few of the upland soils, except the Positas soils, have inherent soil characteristics that make them highly erodible. However, the soils are highly sensitive to disturbance and are highly erodible under several land use situations, including cultivation and grazing. Most cultivated soils have eroded because of slope and the methods used. The SCS (1966) estimated that erosion rates on soils recently used for pasture and range was previously higher, when they were cultivated for dry-farmed grain and grain hay. However, removal of the protective plant cover by overgrazing on most of the uncultivated soils has also caused erosion. (SCS, 1966).

Seismic Hazards

Seismic hazards within the watershed include the potential for ground surface rupture (direct) and secondary hazards such as liquefaction and induced slope failures. Hazards due to ground rupture are primarily considered a risk along traces of active and potentially active faults within the watershed, and would be expected to be confined to areas along the Calaveras Fault zone.

The major secondary seismic hazards of potential concern within the watershed are seismically-induced landslides and liquefaction. Seismically-induced landslides generally occur in areas already susceptible to landslides due to other factors, including the presence of existing landslide deposits (which are extensive in this watershed). Earthquakes may trigger landslides that might not otherwise occur until a later time. Liquefaction is the sudden loss of strength in loose, saturated materials (predominantly sands) during an earthquake, which results in the temporary fluid-like behavior of those materials (much like quick-sand). Liquefaction typically occurs in areas where groundwater is shallow, and materials consist of clean, poorly consolidated, fine sands. Alluvial sediments within the valleys are potentially subject to liquefaction in the event of strong ground shaking.

DRAINAGE BASIN RESOURCE INFORMATION

Watersheds or drainage basins (of any size) are spatial units on the landscape which provide natural management units. Resources in the lower reaches or downslope areas of watersheds are often affected by land use practices in the upper portions and upslope positions within watersheds. Thus, effective management of upstream and upslope areas is important for control of lower basin processes and characteristics (e.g., flooding and flow regime, erosion and sedimentation, water quality). Attempted preservation of downstream resources or water quality may be unsuccessful without consideration of upstream activities.

The analysis and presentation of geologic resource information for the SFWD lands has been conducted with consideration for the natural drainage basin boundaries. The drainage basin boundaries were selected using topographically-based areas, focusing on logical management areas for the existing SFWD reservoirs rather than the pre-existing stream systems alone. This approach focuses on describing and understanding the geologic resources and slope geomorphic system for each topographically-based drainage basin, characteristics that have significance for natural biologic systems, land use opportunities and constraints and impact assessment for proposed actions that may affect the slopes, hydrology, or water quality. A drainage basin approach also facilitates understanding of any inherent geographic variability that produces different management considerations for specific drainage basins and their water resources, including identified reservoirs.

For the Alameda watershed this approach calls out separate drainage basins for: (I) San Antonio Reservoir; (II-A) Calaveras Reservoir and (II-B) Upper Alameda Creek; (III) Lower Alameda Creek; and (IV) Surrounding Drainages. A description of the geographic limits and geologic resource information for each identified drainage basin within the study area is summarized in the following basin data tables.

REGULATORY FRAMEWORK

Mineral Resources

The California Division of Mines and Geology (DMG) classifies the regional significance of mineral resources in accordance with the California Surface Mining and Reclamation Act of 1975 (SMARA). Mineral Resource Zones (MRZ) are identified by the DMG to describe the significance of mineral deposits, and the State Public Resources Code requires that local governments consider significant mineral resources in the planning process. Land use decision-making processes for areas with significant mineral resources on or adjacent to SFWD lands must comply with code requirements to explain the potential effect of land use actions on future resource extraction, and justify permitting uses in conflict with future extraction.

The MRZ categories are as follows:

- MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- MRZ-2 Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood exists for their presence.
- MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.
- MRZ-4 Areas where available information is inadequate for assignment to any other MRZ.

Recent changes in SMARA, specifically Public Resource Code Article 4, Section 2762 and 2763, address the issue of permitting a land use which would threaten the potential to extract mineral resources in an area classified by the DMG as containing significant mineral deposits. The lead agency may cause to be prepared an evaluation of the area to ascertain the significance of the mineral deposit located therein. The results of such evaluation shall be submitted to the State Geologist and the State Mining and Geology Board. In addition, the lead agency shall prepare in conjunction with any environmental document, a statement specifying the reasons for permitting the proposed use and shall forward a copy to the State Geologist and the State Mining and Geology Board. The State may require further studies, including economic analysis to justify local agency decisions.

Seismic Safety

Ground Rupture Hazards

The Alquist-Priolo Special Studies Zones Act (1972), as codified in the California Public Resources Code, regulates development near active faults with the purpose of mitigating the hazard of surface fault-rupture. The principal focus of the legislation is to prohibit the location of developments and structures for human occupancy across the trace of active faults as defined by the State Geology Board. For SFWD the regulation would require specialized geologic reports defining and delineating surface fault rupture hazards prior to undertaking projects that would include structures for human occupancy.

Dam Safety

The California Department of Water Resources (DWR) Division of Safety of Dams is a jurisdictional agency for dams and reservoirs as identified in State Water Code Sections 6000 to

6004.5 and 6025.5. DWR carries out regular inspections of dams and coordinates with the California Office of Emergency Services in evaluating failure scenarios and preparing inundation maps. Neither the State Office of Emergency Services nor the DWR formulates a probability factor for dam failure. All dams under state jurisdiction are regularly inspected by DWR to evaluate structural integrity and seismic safety.

Prime Agricultural Land

Conversion of prime agricultural land to non-agricultural use, or impairment of the agricultural productivity of prime agricultural land is typically considered a significant effect for the purposes of impact assessment pursuant to the California Environmental Quality Act (CEQA). However, no precise definition of "prime agricultural land" is stated in the Public Resources Code. Lead Agencies evaluating projects pursuant to CEQA most commonly rely on federal and state agency definitions of "Prime farmland soils" or "Prime farmland" in developing impact significance criteria.

Prime farmland soils, as defined by the U.S.D.A. Soil Conservation Service (SCS), are soils that are best suited to producing food, seed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. Prime farmland is of major importance in providing the nation's short- and long- range needs for food and fiber production. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment. Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses, although urban or built-up land is not considered prime farmland.

A modification of the SCS system is employed by the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP). The FMMP is charged with inventory and reporting the conversion of agricultural land to and from agricultural use. The FMMP designates eight categories of land use, including Prime Farmland, Farmland of Statewide Importance, Unique Farmland, Farmland of local importance, Grazing land, Urban and built-up land, Other land, and land committed to nonagricultural use.

SENSITIVE RESOURCES

Mineral Resources

Significant aggregate mineral resources have been identified by DMG within the SFWD lands in the Amador Valley and the Sunol Valley. Areas classified as MRZ-2 are restricted to the southern and eastern portions of Sunol Valley, although additional resources (MRZ-3 areas) are identified for other areas of thick alluvial deposits and sedimentary rocks.

Mineral resource extraction on lands outside the SFWD boundary could affect downslope and downstream areas, including locations south of San Antonio Reservoir and downstream of Welch Creek in lower Alameda Creek.

Seismic Hazards and Landslide Hazards

The area along the Calaveras Fault zone is designated as a special studies zone under the Alquist-Priolo Act, and seismic hazards of surface rupture must be adequately evaluated for projects proposing structures for human occupancy.

In addition to the Calaveras Fault zone, other active and potentially active faults are within and near the watershed. The principal locations that may require special consideration are: (1) the western and southwestern margin of the watershed (Calaveras Reservoir and Lower Alameda Creek basins), which is closest to the Hayward Fault, and has other Quaternary faults present; (2) the northeastern margin of the watershed (San Antonio Reservoir basin), which includes a Late Quaternary fault, and is near Holocene and Historically active faults; and (3) the Arroyo de la Laguna canyon, which is immediately downslope of the Calaveras Fault.

Slope stability is an issue that affects most of the SFWD lands, ranging from dispersed small landslides and moderate susceptibility to failures, to vast areas of nearly continuous, large old landslides that have high susceptibility to re-activation. There is a minor degree of spatial segregation among the identified basins. The most extensive areas of large landslides and high hazards are in the upper Alameda Creek and Calaveras Reservoir basins. In addition, the southeastern portion of the San Antonio Reservoir basin and the corridor along Arroyo de la Laguna and Niles Canyon have large existing landslides and/or high susceptibility to slope failures. Several factors affect the susceptibility of slopes to static or seismically-induced slope failures, including variables such as antecedent moisture conditions and the characteristics of a particular earthquake event. It is not possible to predict whether seismically-induced landsliding would be limited to certain portions of the watershed, such as areas along or near active faults.

Soil Stability and Erosion Hazard

Soil erosion status and soil erosion hazard are also widespread issues of concern in the watershed. Over 50 percent of the watershed area has soil mapping units that are described as having experienced moderate topsoil erosion (including a few areas with severe topsoil erosion). These areas are particularly sensitive to further loss of the topsoil, due to the existing limited soil depth, water holding capacity, and fertility. Soil erosion hazard is a measure of the susceptibility of a soil to erosion by sheet wash, rilling or gullying, and is independent of existing erosion status. Numerous soil types throughout the SFWD watershed have erosion hazard ratings of severe and very severe. The highest erosion ratings are generally correlated to

slope angle, with very severe erosion hazards for soils on slopes exceeding 40 and 45 percent, regardless of parent material. A few soils, including the Gaviota rock sandy loam, the Los Osos clay loam, and the Positos gravely loam have severe erosion hazards even at lower slope angles.

Prime Farmland Soils

Several fairly large, continuous areas of soils rated by the SCS as Capability Class I or II exist within the SFWD watershed. These soils are generally considered to be prime farmland soils, although the defined prime farmland areas may further distinguish soils on the basis of available water and recent land use. The largest area of Class I soil is in Sunol Valley, including both the Yolo and Zamora loams. Additional large, continuous areas of Class I and II soils are the Sunnyvale and Sycamore soils in Amador Valley. Smaller and discontinuous parcels of Class I and II soils occur south of Calaveras Reservoir, east of San Antonio Reservoir, and along Alameda Creek terraces in the upper basin.

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Wagner, D.L., E.J. Bortugno, and R.D. McJunkin, 1990, Geologic Map of the San Francisco-San Jose Quadrangle, California Division of Mines and Geology, Regional Geologic Map Series, Map No. 5A (1: 250,000).

ALAMEDA WATERSHED
DRAINAGE BASIN DESCRIPTIONS

BASIN I: SAN ANTONIO RESERVOIR

Introduction:

The natural drainage basin contributing to the San Antonio Reservoir is concomitant with the natural San Antonio Creek watershed, which includes the Indian Creek, La Costa Creek and Williams Gulch subbasins. The areas upstream of the gage, below the dam have been mapped as a subset of the basin, to facilitate comparison of watershed data with gage data. SFWD lands include nearly all of the drainage area north and northeast of the reservoir, and extend eastward to include the downstream portions of each of the major contributing streams. However, the upstream portions of the tributaries are outside SFWD ownership. The following descriptions apply directly to the SFWD lands, and are not necessarily applicable to the entire natural drainage basins.

Management of the SFWD lands in this basin is constrained by their downstream location and relatively small proportion of the entire San Antonio Creek watershed. Land use activities and natural watershed processes in the upper watershed can be a significant driving force affecting the lower watershed conditions.

NATURAL SLOPE SYSTEM:

Topography:

Topography within the SFWD watershed is relatively diverse, with low relief, complex rolling topography north of the reservoir, and high relief, steeply sloping narrow valleys south of the reservoir. On the northwest side, maximum elevations are about 600 to 640 feet above msl, and the SFWD boundary roughly coincides with the topographic watershed boundary. Northeast of the reservoir, the SFWD boundary is approximately at 1000 feet above msl, and downslope of the topographic ridgelines. The farthest southeast portion of the SFWD watershed is along Williams Gulch, reaching an elevation of about 1550 feet along the creek, and about 2000 feet at Rocky Ridge. The SFWD boundary crosses roughly perpendicular to the valleys of San Antonio, La Costa, and Indian Creeks. The maximum ridgetop elevations along the boundary are about 1800 feet, 1300 feet and 1600 feet, respectively, well below the headwater maximum elevations for each of these creeks.

BASIN I: SAN ANTONIO RESERVOIR (Continued)

Faults:

The Calaveras Fault is approximately perpendicular to San Antonio Creek where the creek enters the Sunol Valley at the far western and downstream end of the basin. The principal fault within the basin is the Williams Fault. This northwest-southeast trending fault crossed the eastern, upstream end of the basin. The main trace of the fault forms the eastern ridge above Williams Gulch, extending southeast to the Valle Fault and northwest to the Las Positos Fault. From its junction with the Williams Fault just north of the basin, the Las Postias fault extends to the northeast. About one mile north of the SFWD watershed boundary, the Verona Fault intersects the Las Positas Fault, from which the Verona Fault extends in an arc towards the west and northwest. The Verona Fault consists of three parallel zones, each about 1,000 feet apart. Movement on the northern zone places Miocene marine sediments in contact with continental sediments of the Livermore Formation and acts as a partial barrier to southward flow of ground water along the canyon of Arroyo de la Laguna (California DWR, 1974).

In addition to the above described faults, several other geologic unit contact boundaries are faults, but no evidence of displacement within the past 1.6 million years (the Quaternary) has been established by existing geologic studies. Since some faults are labeled as pre-Quaternary or of unknown activity status due to the reconnaissance nature of existing data, such faults are not necessarily inactive.

Geology:

The geology of this basin is the most diverse of all the SFWD Alameda watershed areas. Franciscan rocks are located southwest of Williams Fault, east of Apperson Ridge, and generally south of the Hetch Hetchy Aqueduct. Several localized areas of serpentinitic rock occur along the fault contacts on Williams Fault and around the basalt and greenstone units on Apperson Ridge. A large block of the Panche Formation outcrops northeast of the Williams Fault, but only a few areas are within the SFWD boundary. Marine sedimentary rocks of the San Pablo Group outcrop south of the reservoir, between the Calaveras Fault and Apperson Ridge. These rocks are overlain by non-marine sedimentary rocks of the Contra Costa Group, exposed south of the reservoir and extending east to Williams Fault.

BASIN I: SAN ANTONIO RESERVOIR (Continued)

Younger, Plio-Pleistocene non-marine sedimentary units, primarily the Livermore Gravels, are dominant north of the reservoir. Dissected older alluvium, younger basin deposits and recent alluvial deposits comprise the valley fill of La Costa Valley, now exposed primarily on the southern and eastern margins of the reservoir.

Mineral Resources: None of the SFWD watershed lands in this basin have been classified as MRZ-2 for aggregate resources, but the adjacent, upslope area on Apperson Ridge is an identified mineral resource sector with a MRZ-2 classification for crushed stone. In addition, the alluvial deposits immediately downstream of San Antonio Reservoir are classified MRZ-3 (areas with mineral deposits, the significance of which cannot be evaluated with available data) for sand and gravel, and the area between Apperson Ridge and Sunol Valley is classified MRZ-3 for crushed stone.

Soils: North of the reservoir, the soils are dominantly Positas and Pleasanton gravelly loams, developed on Livermore Gravels parent material. Small areas of Yolo loam occur along stream terraces of San Antonio Creek downstream of the dam. The Azule clay loam and Azule clay are common to the northeast and south of the reservoir, principally associated with the Contra Costa group parent material. Numerous areas with Diablo clay soils are located on fine textured alluvium and basin deposits on the south side and east end of the La Costa Valley, along with Zamora loam on alluvial terraces.

Along Williams Gulch and San Antonio Creek there are several areas of rock land with little or no soils, and the mosaic of soils in other areas includes Vallecitos rocky loams, Los Osos silty clay loams and Los Gatos loams.

BASIN I: SAN ANTONIO RESERVOIR (Continued)

Slope Stability:

There is a definite geographic difference in the type and extent of landslides within this basin that parallels geologic distributions.

The area north of San Antonio Reservoir, dominated by Livermore Gravels, lacks large landslides, but has several areas with landslides in the range of 200 to 500 feet long. Within areas underlain by the Contra Costa Group, a few large landslides occur, apparently associated with locations having favorable dip of the geologic beds (with the topographic slope).

The largest, most numerous, and most extensive areas of landslides are in areas of the Franciscan Assemblage, primarily along Williams Gulch and San Antonio Creek. Although there are several exceptions, most of the large landslides in and adjacent to the SFWD lands are along the Williams Fault and along the contact zone between the Franciscan rocks and younger sedimentary rocks south of the reservoir (along and south of the Hetch Hetchy Aqueduct).

MODIFIED SLOPE SYSTEM:

Roads and Drainage:

Paved access to the SFWD lands is provided via Vallecitos Valley, but the principal internal roads of the basin are gravel/dirt. The main road traversing this basin is Ranch Road, a gated road that extends from Vallecitos Valley along the northeast end of the reservoir, up the La Costa Valley and to San Antonio Creek and Williams Gulch. This SFWD road serves as access to private properties east of the SFWD boundary. There are numerous additional dirt roads within this basin, some that have several quasi-abandoned or apparent alternate routes. Some of the side roads extend up tributary valleys, including La Costa Creek, Indian Creek, and Apperson Creek. Other roads are along power transmission lines and pipeline easements crossing the watershed. On the northeastern boundary, several off-site roads approach the watershed and could be sources of unauthorized access. The western approach to the dam has multiple roads, with gated access from Calaveras Road along the eastern side of the Sunol Valley.

BASIN I: SAN ANTONIO RESERVOIR (Continued)

Mineral Extraction: No sites of abandoned or active commercial mines or local borrow pits were identified within this basin. However, the western portion of this basin, along Apperson and Indian Creeks, is downslope and downstream of identified significant mineral resources on Apperson Ridge that may be commercially mined in the future.

Stability/Erosion: Soils that have an eroded or severely eroded status, and/or high erosion hazards are more common on the southern side of the reservoir than to the north and northeast. On SFWD lands, the most sensitive soils immediately adjacent to the reservoir are the Gaviota and Positas series (with existing erosion and steep slopes). East of the reservoir, in the San Antonio Creek and Williams Gulch subbasins, severely eroded soils with steep slopes and high erosion hazards occur within and upstream of the SFWD property. Large areas of eroded and erosion-sensitive Los Gatos-Los Osos complex soils also occur within the Indian Creek subbasin, although most of these soils are located upstream of the SFWD boundary.

BASIN II-A: CALAVERAS RESERVOIR

PART A--TOPOGRAPHIC CALAVERAS RESERVOIR BASIN

Introduction:

The natural drainage basin contributing to Calaveras Reservoir includes the Arroyo Hondo and Calaveras Creek sub-basins, and local drainage areas along the west shore, downslope of Monument Peak. The SFWD watershed lands include most of the western slopes and Calaveras Creek contributing areas, but only include a small portion of the Arroyo Hondo drainage basin. The following descriptions apply directly to the SFWD lands, and are not necessarily applicable to the entire natural drainage basins.

Management of the SFWD lands in this basin is constrained by their downstream location and relatively small proportion of the entire Arroyo Hondo watershed. Land use activities and natural watershed processes in the upper watershed can be a significant driving force affecting the lower watershed conditions.

NATURAL SLOPE SYSTEM:

Topography:

Along the west side of the reservoir, maximum elevations on SFWD lands are about 2,200 feet above msl, just downslope of Monument Peak (2,594 feet above msl). The SFWD boundary follows the topography ridge, decreasing southward from about 2,200 feet to about 1,200 feet at Calaveras Road. The southwest drainage basin limit is along the Los Buellis Hills, which peak just over 2,000 feet above msl, and the maximum elevations on SFWD land is about 2,000 feet, along Felter Road, with a maximum elevation along Calaveras Creek of 1,600 feet above msl. The eastern drainage boundary between Calaveras Creek and Arroyo Hondo is along Poverty Ridge, and portions of that relatively flat-topped divide are about 2,800 feet above msl. Oak Ridge forms the drainage divide between Arroyo Hondo and Alameda Creek, with maximum elevations of just over 3,000 feet.

The topography varies from nearly level and simple sloping surfaces, like the area south of the Calaveras Reservoir, to very steeping sloping canyon walls along Arroyo Hondo, and complex, rolling steeply sloping areas within the Calaveras Creek subbasin.

BASIN II-A: CALAVERAS RESERVOIR (Continued)

Faults:

The prominent active fault within this basin is the Calaveras Fault (northern segment), with several parallel lineaments trending nearly north-south through the reservoir. The fault orientation shifts more southeasterly near the southern end of the reservoir, and branches of the Calaveras Fault (central segment) continue south and southeasterly beyond the watershed boundary.

Calaveras Reservoir segment is the portion of the fault between the southern end of Calaveras Reservoir and the southern end of the Sunol Valley. Unlike the northwest-trending segments to the north and south, this segment trends roughly north-south and occupies a 1.5 to 3.0 km wide bend in the fault zone. The Calaveras Reservoir segment is unlikely to produce an independent large-magnitude earthquake because of its short length and location along a bend in the fault zone (Simpson and others, 1992). The segment is most likely to rupture in association with a neighboring segment to either the north or south (multiple late-Holocene events are documented along the Calaveras Reservoir segment of the fault at Leyden Creek (Kelson and others, 1992).

The Mission Fault is approximately parallel, and west of the Calaveras Fault, located east of the aligned ridge with Mission Peak, Mt. Alison, and Monument Peak. The portion of the fault within the SFWD watershed is along Weller Road.

In addition to the above described faults, several other geologic unit contact boundaries are faults, but no evidence of displacement within the past 1.6 million years (the Quaternary) has been established by existing geologic studies. Since some faults are labeled as pre-Quaternary or of unknown activity status due to the reconnaissance nature of existing data, such faults are not necessarily inactive.

Geology:

West of the Calaveras Fault, the principal bedrock units are Cretaceous sedimentary rocks of the Great Valley Sequence, consisting of interbedded sandstone siltstone, shale, and conglomerate. Tertiary marine deposits overlie the Great Valley sequence and include several sandstones, siltstones, and shales of the Monterey and San Pablo Groups, and the sandstone and conglomerate of the Temblor Formation.

BASIN II-A: CALAVERAS RESERVOIR (Continued)

East of the Calaveras Fault, the principal bedrock units are Cretaceous rocks of the Franciscan Complex. Within the Calaveras Reservoir basin, the most dominant Franciscan rocks are sandstones (graywacke) and shales, with distinct lenses of greenstone and lineaments of mixed rocks, mostly micaecous shale or siltstone that have been pervasively sheared, with fragments of graywacke sandstone (Dibblee, 1973).

Along the Calaveras Fault Zone, near the dam (in the vicinity of the natural confluence of Arroyo Hondo and Calaveras Creek), serpentinized and intrusive ultramafic rocks are in fault contact with various sedimentary units, particularly the Berryessa and Temblor Formations.

A few large areas of Quaternary sedimentary deposits occur in this basin. Distinct upland patches of old alluvium have been identified on Poverty Ridge, and as dissected fan and terrace deposits south of the reservoir. Younger alluvium is concentrated at the southern end of the reservoir (on Calaveras Creek) and along the Mission Fault. No significant alluvial deposits have been identified within the narrow Arroyo Hondo valley, although numerous colluvial (slope) deposits are present.

Mineral Resources: Although a relatively large area of alluvial sediments occurs south of the reservoir, no areas in this basin have been identified by the State Geologist as having significant mineral resources.

Soils: On the steeper upper slopes west of the reservoir, there are large areas of San Andreas fine sandy loam. In the more nearly level alluvium along Mission Fault, areas of San Ysidro loam occur, while the lower slopes and valleys draining to the reservoir from the west have a mosaic of Los Osos clay loams and Gaviota gravely loams. Gaviota gravelly loams and the Gaviota-Los Gatos complex is dominant on the slopes and side valleys of Calaveras Creek south of the reservoir. Yolo loams have developed on the alluvial terraces immediately south of the reservoir, with Pleasanton gravelly loams and Zamora loams on some of the valley margin deposits. On the southeast side of the creek, the only areas of Clear Lake clay and Hillgate silty clay loam on SFWD lands occur.

BASIN II-A: CALAVERAS RESERVOIR (Continued)

Along Arroyo Hondo, soil types south of the creek (the north and northeast facing slopes) are a mosaic of Los Gatos gravelly loams and Gaviota loam. The northern side of the creek has large areas of rockland, and Gaviota loams on very steep slopes. The other major soils on the north side of Arroyo Hondo are Vallecitos rocky loams.

In the vicinity of the Calaveras Dam, rock land with little soil is present west and north of the dam, with Los Gatos loams and Los Osos silty clay loams on the east side of the dam and reservoir.

Slope Stability: Within this basin, there is a difference in the extent and type of landslide deposits between the Calaveras Creek and Arroyo Hondo subbasins.

The Calaveras Creek watershed tends to have numerous, dispersed small landslides (less than 500 feet long), and a few large landslides. The large landslides are located west of the reservoir, and near the southern end of the reservoir, along contacts between the Briones Sandstone (San Pablo Group) Monterey Shale (Monterey Group), and the Berryessa Formation.

The Arroyo Hondo subbasin, and the reservoir shoreline southeast of the Calaveras dam have extensive, nearly continuous areas of large landslides. Generally, the largest, most extensive slides are on the northeast side of Arroyo Hondo, along shear zones within the Franciscan Assemblage.

MODIFIED SLOPE SYSTEM:

Roads and Drainage: This basin has two major County roads crossing it, one paved road with public access, and one gravel road with controlled access. Calaveras Road, along the western ridge and shoreline is a paved roadway that provides unrestricted access to and from the Sunol Valley. Marsh Road is a gated gravel road that is used for access to private lands east and southeast of the SFWD property. In addition, Weller Road along the western ridgeline is used for access to private lands and communications facilities near Monument Peak and Mount Allison. Several gravel/dirt internal maintenance and access roads are also present within this basin, including roads along Poverty Ridge, Strawberry Point (east shore of Reservoir by Arroyo Hondo), Oak Ridge (and the diversion tunnel) and in the vicinity of the Calaveras Dam.

BASIN II-A: CALAVERAS RESERVOIR (Continued)

Mineral Extraction: No sites of abandoned or active commercial mines or local borrow pits were identified within this basin.

Stability/Erosion: There are few areas of the immediate contributing drainage basin to Calaveras Reservoir which are not eroded, or highly susceptible to erosion. The most stable areas are restricted to the alluvial lowlands on the south end of the reservoir, the gentler slopes on the southeast side of the reservoir, and the relatively low slope-angle surfaces in the upstream portion of the watersheds (primarily occurring on southwest-facing slopes).

Eroded, steeply sloping San Andreas soils occur along the western SFWD boundary, near the basin boundary. The other areas draining to the Calaveras Reservoir from the west include severely eroded, steeply sloping Gaviota and highly erodible Los Gatos and Gaviota soils.

There are large, nearly continuous areas of eroded, steeply sloping surfaces with Gaviota, Los Gatos, and Vallecitos soils in the Arroyo Hondo and Calaveras Creeks sub-basins upstream of the reservoir. These areas include many previously eroded soils that have developed on landslide deposits, and are therefore subject to both surface erosion and slope instability.

BASIN II-B: UPPER ALAMEDA CREEK

PART B--ALAMEDA CREEK ABOVE THE CALAVERAS RESERVOIR DIVERSION DAM

Introduction:

The upper basin is designated, for the purposes of this analysis, as the drainage basin of Alameda Creek above the Diversion Dam (to Calaveras Reservoir). The natural watershed area of the Upper Alameda Creek basin extends about 10 miles southeast of the diversion, but the SFWD lands are concentrated along the reach within three miles of the diversion. The following descriptions apply directly to the SFWD lands, and are not necessarily applicable to the entire natural drainage basin.

Management of the SFWD lands in this basin is constrained by their downstream location and relatively small proportion of the entire Alameda Creek watershed. Land use activities and natural watershed processes in the upper watershed can be a significant driving force affecting the lower watershed conditions.

NATURAL SLOPE SYSTEM:

Topography:

Oak Ridge, with a maximum elevation just over 3,000 feet above msl, forms the drainage boundary between Alameda Creek and Arroyo Hondo. SFWD lands extend up the Alameda Creek valley to about 1,200 feet at the creek crossing, and extend upslope towards Oak Ridge on the south and Valpe Ridge on the north. The SFWD boundary on the north side of Alameda Creek is just south of Apperson Ridge, near the headwaters of Welch Creek at and elevation of about 2,300 feet, which is about 400 feet below the ridgetop.

Faults:

The Calaveras Fault zone is immediately west of, and approximately perpendicular to, Alameda Creek at the confluence with Calaveras Creek. The fault is not within the upper Alameda Creek basin.

Several of the geologic unit contact boundaries within the upper Alameda Creek basin are faults, but they have no evidence of displacement within the past 1.6 million years (the Quaternary). Since some faults are labeled as pre-Quaternary or of unknown activity status due to the reconnaissance nature of existing data, such faults are not necessarily inactive.

BASIN II-B: UPPER ALAMEDA CREEK (Continued)

Geology:

This basin lies east of the Calaveras Fault zone, and the bedrock geology is dominated by Franciscan rocks. Along the reach of Alameda Creek within SFWD lands, the rock units have complex, faulted contacts, with several areas of melange (a mix of Franciscan rocks in a sheared shale matrix). A large number and total area of serpentinitic rock units are within this basin, primarily on the upper slopes of the ridges north and northeast of the creek.

At the extreme downstream end of the basin, a few fault-bounded blocks of the San Pablo Group sandstones are interspersed with Franciscan glaucophane blueschist and related schists, although many of the contacts are obscured by landslide deposits.

Small areas of Quaternary alluvial deposits, as channel and terrace units, occur along the creek, with older alluvial fan and terrace deposits north of the confluence with Calaveras Creek.

Mineral Resources:

No areas of significant aggregate mineral resources have been identified by the State Geologist within this basin or on the ridges draining to this portion of Alameda Creek.

Soils:

The Los Gatos-Los Osos complex is common on the south side of the creek upstream past the diversion tunnel, with Vallecitos rocky loams prevalent along Oak Ridge. The northern side of Alameda Creek is dominated by Vallecitos rock loams along the lower slopes, punctuated by rocky outcrops. The upper slopes north of the creek have Henneke rocky loams on serpentinitic parent material, with rockland patches. This basin is the principal portion of the SFWD watershed that has Henneke soils, although serpentinitic rocks are located in several of the basins.

Narrow areas of Yolo silt loams occur along stream terraces and an area of Altamont clay is adjacent to the creek at the eastern end of the SFWD lands.

Slope Stability:

The largest individual landslides, and some of the most extensive areas of coalescing, or adjacent individual landslides in the SFWD lands are along this portion of Alameda Creek. The landslides occur on both sides of the creek, within areas of Franciscan melange and associated with shear zones and fault contacts within the Franciscan Assemblage units. There are few areas of the slope system along this reach of the creek that do not have large upslope landslide deposits mantling the bedrock units.

BASIN II-B: UPPER ALAMEDA CREEK (Continued)

MODIFIED SLOPE SYSTEM:

Roads and Drainage: The principal road within this basin is the gravel/dirt road along Alameda Creek, providing gated access to the SFWD diversion dam and Ohlone Regional Park. A few side roads are present, extending towards the northern basin ridges.

Mineral Extraction: No sites of abandoned or active commercial mines or local borrow pits were identified within this basin.

Stability/Erosion: The only portions of the Upper Alameda subbasin that are not highly sensitive to erosion or previously eroded are the isolated areas of nearly level alluvial deposits in the valley bottom and areas of convex ridge top surfaces and relatively low angle slopes (less than 30 percent).

The majority of slopes draining directly to the creek throughout the SFWD properties, and extending upstream of the boundary, are eroded or severely eroded, with high or severe erosion hazards, and slope angles exceeding 45 or 50 percent.

BASIN III: LOWER ALAMEDA CREEK

Introduction:

Lower Alameda Creek conveys runoff from a large area and many individual stream watersheds in the Diablo Range and Livermore Valley. The southeastern tributaries in the Diablo Range include Calaveras Creek, Arroyo Hondo, and San Antonio Creek. Runoff routed to the creek through Arroyo de la Laguna originates from areas surrounding Livermore Valley, and small tributaries like Sinbad Creek contribute additional runoff within Niles Canyon. SFWD lands are located primarily along Lower Alameda Creek in the Sunol Valley and Niles Canyon, and within the downstream end of the southeastern tributaries. A very large proportion of the contributing areas to the lower Alameda Creek system are outside of SFWD ownership. The following descriptions apply directly to the SFWD lands, and are not necessarily applicable to the entire natural drainage basin.

Management of the SFWD lands in this basin is constrained by their downstream location and relatively small proportion of the entire Alameda Creek watershed. Land use activities and natural watershed processes in the upper watershed can be a significant driving force affecting the lower watershed conditions.

NATURAL SLOPE SYSTEM:

Topography:

SFWD lands encompass several of the local drainages on the east and west sides of the Alameda Creek valley between Calaveras and San Antonio Creeks. Maximum elevations on the west side decrease from about 2,000 feet near Mission Peak to about 800 feet between Pirate and Sheridan Creeks. Along the east side, several small drainages with headwater elevations about 1,200 feet above msl are within the SFWD boundary, although on the lower portions of Indian and Welch Creeks are included.

Nearly all of the Sunol Valley floor, and immediately surrounding slopes, are within the SFWD boundaries. The only other broad expanse of flat topography are the outlier parcels of property along Arroyo de la Laguna at the extreme southwest corner of the Livermore Valley. The surface elevations along Arroyo de la Laguna are about 320 feet above msl, dropping almost 100 feet to the Suno Valley. Along Niles Canyon, Alameda Creek continues to drop elevation quickly, to about 180 feet just west of the SFWD boundary. The maximum elevation on the ridge south of the creek is about 1200 feet above msl, creating local relief of about 1,000 feet.

BASIN III: LOWER ALAMEDA CREEK (Continued)

Faults:

The Calaveras Fault (northern) traverses the entire length of the study area, and, in conjunction with associated faults, controls the basic valley structure and geomorphology.

The San Ramon segment of the northern Calaveras Fault is the portion of the fault adjacent to SFWD lands along Arroyo de la Laguna. The fault location is concealed in places by large Quaternary landslides on Pleasanton Ridge. The portion of the fault south of Pleasanton Ridge is the Suno segment, which extends along the entire eastern margin of the Sunol Valley, within SFWD lands. Although it is poorly expressed in the southern part of the Sunol Valley, it forms a prominent linear range front along the northeastern margin of the valley.

Two associated faults of Late Quaternary or Quaternary age that also delimit the Sunol Valley include the Sinbad and Stonybrook Faults. The Sinbad Fault branches from the Calaveras Fault near the southern end of the Sunol Valley, forming the western margin of the valley, crossing the floor of the valley to Sinbad Canyon, north of Alameda Creek (DWR, 1974). The Stonybrook Fault branches from the Sinbad Fault near Highway 680 and trends northwesterly to form the western margin of the Sunol Valley to Niles Canyon (DWR, 1974). Both of these faults are indicated by the prominent linear range front and faceted spurs, although their location is concealed by alluvial fan deposits (the Sinbad and Stonybrook Faults were not mapped by Dibblee (1980).

The westernmost SFWD boundary within Niles Canyon is within two miles of the Mission/Chabot fault zone and less than three miles from the Hayward Fault Zone.

In addition to the above described faults, several other geologic unit contact boundaries are faults, but no evidence of displacement within the past 1.6 million years (the Quaternary) has been established by existing geologic studies. Since some faults are labeled as pre-Quaternary or of unknown activity status due to the reconnaissance nature of existing data, such faults are not necessarily inactive.

Geology:

Located along and west of the Calaveras Fault, this basin has little or no exposures of the Franciscan assemblage. Rather, the dominant bedrock unit is the Panoche Formation of the Great Valley Sequence. This marine sedimentary rock unit is dominant on the uplands northwest of Highway 680 and along the western margin of the Sunol Valley.

BASIN III: LOWER ALAMEDA CREEK (Continued)

Geology: cont'd

Non-marine Plio-Pleistocene deposits, primarily the Livermore Gravels, occur as valley-margin units on the western and northern end of the Sunol Valley, and along the eastern side of Arroyo de la Laguna. Possible exposures of the Livermore Gravels on the western side of Arroyo de la Laguna are obscured by the large Quaternary landslide deposits downslope of the Calaveras Fault.

Large areas of Quaternary alluvial sediment occur as valley fill at the southern end of the Amador Valley (above Arroyo de la Laguna) and throughout the Sunol Valley. A few patches of alluvium of various ages are also present in upper Niles Canyon.

Mineral Resources:

The entire Sunol Valley south of Highway 680, and a portion north of the highway, have been classified as MRZ-2 for aggregate resources. Several portions (in the vicinity of the active quarries) are quantified as sectors for sand and gravel suitable for Portland cement concrete.

The area of Sunol Valley northwest of Highway 680 and near the Arroyo de la Laguna confluence with Alameda Creek has been classified by the State Geologist as MRZ-1 (areas where information indicates that no significant aggregate resources exist). However, several other adjacent areas of older alluvial sediments and soft sedimentary rock have been identified as MRZ-3 zones.

One large hard rock mine quarry, that was used as a borrow site for dam construction is just downstream of the Calaveras Dam and adjacent to Calaveras Creek. No additional commercial resources have been identified in the vicinity.

Soils:

At the northern end of this basin, in the Amador Valley, an extensive area of San Ysidro loams, Sunnyvale clay loams and Sycamore silt loams occurs on SFWD lands. Within the Arroyo de la Laguna canyon, Zamora silt loams and Yolo loams occur on the alluvial terraces. On the slopes east of Pleasanton Ridge, Los Osos and Millsholm silty loams have developed in older alluvium and weathered sedimentary rocks.

Positas gravely loams have developed on the Plio-Pleistocene age sedimentary units, located on the north and western sides of the Sunol Valley in this basin.

BASIN III: LOWER ALAMEDA CREEK (Continued)

Soils: cont'd

Within the Sunol Valley, a variety of soils have developed on alluvial deposits of varied age and texture. Upstream of San Antonio Creek, Pleasanton gravelly loams have developed on extensive terraces along the western valley margin, becoming discontinuous upstream of Welch Creek. The younger alluvium in the central portion of the valley is primarily a Yolo loam over gravel between Welch Creek and San Antonio Creek. In the broad valley downstream of San Antonio Creek, the active river channel is along the west side, with Yolo loam over gravel, Yolo loam, and Zamora silt loam in a transect from west to east.

Upland soils west of the Sunol Valley are principally Millsholm silt loam, Los Gatos Loam, Los Osos silty clay loam, and a few areas of Danville silty clay and Clear Lake clay near Sheridan Creek.

Near the confluence of Alameda and Calaveras Creeks, downstream of the Diversion Dam, the slopes have areas of little or no soil, with adjacent areas of Los gatos loams and Los Osos silty clay loams in a complex mosaic.

Slope Stability:

The distribution of landslides within this basin is primarily associated with the fault alignments. A major area of coalescing landslides is located along the Calaveras Fault on the east side of Pleasanton Ridge, upslope of the SFWD lands along Arroyo de la Laguna. A few large landslides occur along Niles Canyon and along Stonybrook fault on the west side of Sunol Valley. The other areas of large landslides are on the margins of the southern Sunol Valley, adjacent to Alameda Creek, and along the Calaveras and Sinbad Faults.

MODIFIED SLOPE SYSTEM:

Roads and Drainage:

Numerous public access roads and highways intersect this basin, including: (1) Highway 680, crossing from north to southeast through Arroyo de la Laguna and the Sunol Valley; (2) Highway 84, crossing west to east through Niles Canyon and Vallecitos Valley; and (3) numerous county and private roads that provide access for Pleasanton, Sunol, the Castlewood Country Club, Scotts Corner, and Welsh Creek. The valley floors are also criss-crossed by internal gravel/dirt roads used principally by SFWD and gravel mining operators.

BASIN III: LOWER ALAMEDA CREEK (Continued)

Mineral Extraction:	This basin is the location where commercial gravel operations have been, and will continue to occur.
Stability/Erosion:	Within this large, diverse drainage area there are several locations with relatively low erosion hazard, including: the SFWD lands along Arroyo de la Laguna Creek, most of the Vallecitos valley subbasin, the Sunol Valley floor, the Sheridan Creek drainage, and other areas of gentle topography near Mission Pass. Nearly all areas of relatively steep topography, with slope angles over 30 percent, have soils that have been previously eroded, and/or are highly susceptible to erosion. The fault-bounded valleys tend to have fairly abrupt changes in topography, so areas along the margins of the valleys may be affected by upslope soil erosion or slope instability. The most distinct, large areas of high erosion sensitivity are: the western side of the Sunol Valley downstream of Calaveras Dam, the east side of the Sunol Valley north of San Antonio Creek, and the Niles Canyon area west and downstream of the Sunol Valley.

2.0 VEGETATION

REGIONAL OVERVIEW

The Alameda Watershed owned by SFWD encompasses approximately 40,000 acres and includes both the Calaveras and San Antonio reservoirs. It is located in the central portion of the Diablo Range in Alameda and Santa Clara Counties, California. Calaveras Reservoir straddles the fault of the same name, that separates Franciscan rocks of the Mount Hamilton Range, a part of the Diablo Range, from the Great Valley Sequence of the Hayward Hills. West-facing slopes in the vicinity of Calaveras Reservoir are covered with grasslands while north-and east-facing slopes are covered with oak woodland and brush in the drier locations. San Antonio Reservoir, which resulted from damming San Antonio Creek, fills a wide valley composed of marine and continental shale and sandstone conglomerate. In the vicinity of San Antonio Reservoir, the landscape is primarily grassland with small areas of brush and woodland on north-facing slopes. Riparian woodland occurs in moister drainages especially along San Antonio Creek. Grazing is widespread in watershed grasslands.

RESOURCE DESCRIPTION

Figure 2-1 is a map of the 18 natural community/cover types occurring on the Alameda Watershed. The community delineations were derived from a number of sources including: existing literature, interpretation of color aerial photography, color infrared scanner imagery, and limited field visits. The primary literature sources include: species mapping of forest trees (Griffin and Critchfield 1972), a county-wide hardwood inventory (California Department of Forestry and Fire Protection), and historic Vegetation Type maps (USDA Forest Service). These data sources were used to delineate watershed vegetation based on the Natural Community classification system created by the California Department of Fish and Game (Holland 1986). The Natural Community system was selected as a uniform classification system to use on both watersheds. For each mapped community, a complete table appears at the end of this section that gives the plant and animal species that characterize the natural community together with associated species, structural characteristics, type of terrain occupied, special status species potentially found in the community and sensitivities of the community to human and naturally occurring impacts.

Natural Vegetation Communities

There are numerous natural communities within the vicinity of San Antonio Reservoir and Calaveras reservoirs. These communities are limited to specific locations by physical characteristics of the land, such as soils, and direct or indirect sunlight. Most importantly, they are limited by the amount of water received, through rain and/or fog drip or conversely the amount lost through evapotranspiration because of exposure to wind or solar insolation. Many of the natural communities are able to withstand dry Mediterranean summers because of deep roots and physiological adaptation. The vegetative communities of the Alameda Watershed are described below on the basis of distributional limits, habitat requirements, community sensitivities, and plant species characteristically found in conjunction with each assemblage.

The non-native grassland community is the dominant feature in the Alameda Watershed on flat and gently sloping valleys. This community has been enhanced from years of cattle grazing, while native vegetation such as perennial needlegrass or bunchgrass communities have deteriorated. The conversion of native perennial grassland into non-native annual species has resulted from a combination of changes in the kinds of grazing animals and their grazing patterns, invasion by alien plant species, cultivation, and changes in fire regime (Heady, 1988).

The non-native grassland community is dominated by a number of introduced annual grasses which include soft chess (*Bromus [mollis] hordeaceous*), ripgut grass *(Bromus diandrus*), foxtail brome *(Bromus rubens*), wild oat (*Avena barbata and A. fatua*), and foxtail barley (*Hordeum jubatum*). In areas where this community borders wetlands it is often dominated by perennial rye-grass (*Lolium perenne*) and rabbit's-foot grass *(Polypogon monspelensis*). Non-native grassland is generally found on fine-textured, usually clay soils, which are moist to waterlogged during winter rains and dry during the summer and fall (Holland, 1986). It is typically composed of a dense to sparse cover of annual grasses, often associated with numerous species of annual and perennial forbs. These grasslands grow actively during winter and spring, while remaining dormant during summer and early fall, persisting only as seed until conditions are favorable for germination (Holland 1986). The rapid early growth of annual grass species allows them to shade out the later germinating native perennial grasses.

The most common serpentine-dependent community found in this area is serpentine bunchgrass grassland. In heavily grazed areas of Santa Clara County, the dominant bunchgrass species is *Stipa pulchra.* Areas that have not been cattle grazed have up to five bunchgrass species in equal abundance (McCarten 1987). In the Alameda Watershed, serpentine bunchgrass grassland is

located on the north-east side of the filtration plant; it is dominated by introduced annual grasses such as soft chess *(Bromus [mollis] hordeaceous),* with bunchgrass species such as purple needlegrass (*Nasella [Stipa] pulchra*), nodding needlegrass (*Nasella cernua*) and foothill needlegrass (*Nasella lepida*) forming dense clusters covering up to 20 percent of the soil. Other grasses such as melic grass *(Melica californica),* and bluegrass *(Poa [scabrella] secunda)* also grow with California poppy (*Eschscholtzia californica)*, tarweed *(Hemizonia congesta* ssp. *luzulifolia),* and bird's-foot trefoil (*Lotus subpinnatus).*

The valley oak (*Quercus lobata*), is California's largest broad-leafed tree. It is abundant in the vicinity of San Antonio and Calaveras reservoirs. This community is typically more open than other oak woodland communities, with a grassy understory of non-native grassland composed of wild oat, soft chess and ripgut grass and some native species such as creeping wildrye grass (*Elymus triticoides*); most stands consist of trees that have an open canopy growth form and seldom exceed 30-40 percent cover. Soil conditions often control valley oak woodland distribution. In the vicinity of San Antonio Reservoir, valley oaks occur near the reservoir where there are deep, well-drained alluvial soils and individual trees are likely rooted in permanent sources of water. Generally, this community intergrades with riparian forest near streams in canyons. Many large specimens are also found along the top of Poverty Ridge between Calaveras Reservoir and Arroyo Hondo. Adjacent to chaparral, valley oaks occur on deeper, rocky soils. Valley oaks also intergrade with coast live oak, California bay (*Umbellularia californica*), California buckeye (*Aesculus californicus*) and big-leaf maple (*Acer macrophyllum*) in the moist areas on slopes to form the mixed evergreen forest / coast live oak woodland, and with blue oak where it is drier at 1,000 feet in elevation and above. In the Alameda Watershed, this community ranges from 230 feet to 3,000 feet in elevation.

On north-facing slopes that have been protected by fences or are too steep for grazing, grassland has given way to the shrubs. These shrubs include scrub and chaparral communities such as northern coastal scrub, chamise chaparral, and northern mixed chaparral, all of which are able to withstand the drier conditions and rockier substrates that often occur on hillsides in this area.

Northern coastal scrub consists of low shrubs and on the slopes above Calaveras Reservoir they are in a moderately open community with grass and herbaceous species in the openings. It occurs on shallow, rocky soils of exposed areas on steep slopes with eastern and southern exposure. Northern coastal scrub is dominated by sagebrush (*Artemesia californica*), coyote brush (*Baccharis pilularis var consanguinea),* and bush or sticky monkeyflower (*Mimulus aurantiacus).* The general range of this community is primarily on the outer and inner Coast

Ranges with the species representation changing from a greater proportion of coyote brush near the coast to a greater proportion of sagebrush in the inner ranges such as the Alameda Watershed.

Chamise chaparral (*Adenostoma fasciculatum*) is associated with hot, xeric sites (south and west facing slopes and ridges) and is includes fire-adapted species. This community exists in a mosaic with other communities, such as northern mixed chaparral. Typical species include the dominant chamise, manzanita (*Arctostaphylos* sp.), ceanothus species (*Ceanothus* sp.), Yerba Santa (*Eriodictyon californicum)* and deer brush *(Lotus scoparius*). It has a dense canopy with no understory and very little litter and as with many fire dependent communities becomes scenescent in the absence of disturbance.

Northern mixed chaparral community is composed of broad leafed sclerophyll shrubs, typically manzanita and ceanothus species, that form a dense, often impenetrable canopy. It is usually found on dry, rocky, typically south facing steep slopes with little soil. Species in this community include scrub oak (*Quercus dumosa*), chamise *(Adenostoma fasciculatum),* western poison oak *(Toxicodendron diversilobum)*, and manzanita and ceanothus species. Growth is highest in spring and much reduced in the late summer-fall dry season. This community is adjacent to, but on rockier soils than oak woodland or non-native grassland. Many of the species, particularly the herbaceous plants, are fire dependent and only germinate within a certain period after a burn; a number of the shrub species, particularly the manzanitas are adapted to stump sprouting and grow back very rapidly after a fire.

Sycamore alluvial woodland community is an open to moderately closed, winter deciduous broad-leafed riparian woodland. It occurs in braided depositional channels of intermittent streams, usually with cobblestones or boulder type substrate; San Antonio Creek is a prime example. Common species in this community are California sycamore (*Plantanus racemosa*), with California buckeye (*Aesculus californic*a), and blue elderberry (*Sambucus mexicana*) widely spaced in the subcanopy. Occasionally there are cottonwoods (*Populus fremontii*) and valley oaks mixed into this woodland. The understory is made up of introduced grasses or mule fat (*Baccharis [viminea] salicifolia)*. Sycamores reproduce vegetatively giving the woodland an arrangement consisting of dispersed small groups of trees or copses. In general, this community is restricted to the South Coast Ranges and Alameda County is the most northerly extent of its range.

Three other riparian communities are found on the Alameda Watershed. Central coast arroyo willow riparian forest, white alder riparian forest and central coast live oak riparian forest. White alder riparian forests are supported along the banks of rapidly flowing, perennial streams. Rooted in gravel or sand, alders contain bacteria within their root tissues that fix nitrogen. By the expenditure of energy these organisms can convert atmospheric nitrogen to nitrogen compounds that the alder uses to produce proteins within its cells. This allow the alders to colonize areas that have not yet developed soil and to do so very successfully; alders and their root nodule bacteria actually contribute (or leak) excess nitrogen to the aquatic environment.

The willow riparian occurs in the moist canyons with perennial or at least intermittent stream flow. Arroyo willow grows to 20 feet in a large, dense, shrubby growth form, creating large thickets that provide valuable cover for birds and mammals. Willows also support a wide variety of insects that are fed upon by migratory birds, particularly warblers and bush tits and other small insectivorous birds.

Coast live oak riparian forest is quite close in habitat value to the oak woodlands. It is usually found on ephemeral stream courses and is the driest of the four riparian natural communities. In the watershed, coast live oak is the dominant tree in this community with an understory of western poison oak, blackberry (*Rubus ursinus*), mugwort (*Artemisia douglasiana*), coyote brush, snowberry (*Symphoricarpos mollis*), and elderberry.

In a number places where streams and arroyos discharge to the reservoirs, sand and sediment suspended in the stream water has been deposited in deltaic formations. These deltas are saturated during the time that the reservoir levels are normal to high and these areas support the growth of emergent wetland vegetation. This natural community is defined as coastal and valley freshwater marsh. While the plants that grow in these marshes are colonizing species and not rare, the habitat type has been disappearing in California with increased pressure for land conversion to agriculture and development. Freshwater marshes also support a large number of animal species, and a fairly large number of these animals have special status because of population declines due to loss of habitat.

SENSITIVE RESOURCES

Rare Natural Communities

Some plant communities in the Alameda Watershed are currently considered sensitive or rare by the state and/or local counties because of limited distribution locally or regionally. Valley oak woodland community, is on the California Native Plant Society's (CNPS) list 4 because of limited distribution and serpentine bunchgrass grassland and sycamore alluvial woodland community are listed as rare on the California Natural Diversity Data Base maintained by the California Department of Fish and Game (CDFG).

A natural community or habitat is valued by society on the basis of a least the following characteristics: 1) the size and quality of the habitat area and the presence or absence of fragmentation; 2) surrounding land uses and the compatibility of the habitat with these uses; 3) the status of the habitat in terms of it areal extent, is it rare either due to its only occurring in a few localized places or rare due to declining extent from losses; 4) the species diversity of plants and/or animals dependent upon the community; 5) the dependence upon the community by animals (or more rarely plants) that are of economic or social value to the human population; and, 6) the presence (or absence) of special status species of plants or animals.

The state (CNDDB) ranks communities based on the overall "condition or value" (see Table 1) within California, a threat number is often appended to the "rarity" number. If there are less than six occurrences of a species or a natural community or at total of less than 2,000 acres the state uses the category of S1. If a community is within this category and is very threatened by human or natural agency the community is ranked S1.1; if the community is only threatened it is ranked S1.2; and, if it is under no current threat it is ranked S1.3. When between 6 and 20 occurrences of a species or natural community are known or a total occurrence of between 1,000 and 3,000 individuals or 2,000 and 10,000 acres, the species or habitat is placed in the category S2. The same threat ranking is assigned. The category S3 is assigned when there are 21 to 100 occurrences of the species or 3,000 to 10,000 individuals or 10,000 to 50,000 acres of community. This is a somewhat arbitrary and subjective system based on Holland's classification of communities and an unidentified staff member's perception of threat. Holland's (1986) geographically structured community system will be changing to a more quantitative model such as Allen, et al. (1989), in which formations such as Hardwood Forest are divided into Series that will be named by their component species listed in order of dominance. At the present time, however, CNDDB uses this general ranking of communities and species in terms of the

importance of preserving them. Listed species are protected by Federal and State law but communities are only protected by CEQA if local jurisdictions consider them to have value and create policy that states this.

Special Status Plant Species with Potential to Occur on Alameda Watershed

No special status species of plants were plotted on the California Natural Diversity Data Base (CNDDB) overlays of either La Costa Valley or Calaveras Reservoir 7.5 minute quadrangles ordered from the California Department of Fish and Game (CDFG) in 1993. The CNDDB printout of data on Rarefind, the database of rare and endangered plants and animals maintained by CDFG for these quads contains no reports of special status plant species within the watershed boundaries. This, however, is a common occurrence in an area that has been essentially closed to the public except by permit. The list of plant species reported for this general section of Santa

TABLE 2-1: RARE NATURAL COMMUNITIES OF THE ALAMEDA WATERSHED

	Rarity*
Sycamore Alluvial Woodland	S1.1
Freshwater Marsh	S2.1
Valley Oak Woodland	S2.1
Serpentine Bunchgrass	S2.2
Central Coast Arroyo Willow Riparian Forest	S3.2
Central Coast Live Oak Riparian Woodland	S3.2
Blue Oak Woodland	S3.2
Valley Needlegrass Grassland	S3.1
White Alder Riparian Forest	S4
Northern Coastal Scrub	S4
Northern Mixed Chaparral	S4
Chamise Chaparral (Chamisal)	S4
Non-native Grassland	S4
Mixed Evergreen Forest/	S4
Coast Live Oak Woodland	S4
Coastal Deciduous Woodland Stream (Riverine)	S4

* Rarity Code gives state ranking followed by level of endangerment. For example, Sycamore Alluvial Woodland has the highest ranking and highest level of endangerment.

SOURCE: Environmental Science Associates, 1993.

Clara and Alameda Counties in the California Native Plant Society (CNPS) *Inventory of Rare and Endangered Plants of California* (Smith and Berg 1988) was compiled and compared to the *Flora of the Mount Hamilton Range* (Sharsmith 1982).

Thirty-six plant species that potentially could occur in the natural communities of the Alameda Watershed have special status listing on the state or federal level. Non-native grassland provides habitat for balsam root (*Balsamorhiza macrolepis* var. *macrolepis*), a CNPS list 3 species which is found in open grasslands on hillsides or knolls. Serpentine bunchgrass grassland is habitat for the Jepson's woolly sunflower (*Eriophyllum jepsonii*), a CNPS list 4 species. Several species of concern occur in the northern mixed chaparral community including: Mt. Diablo phacelia (*Phacelia phacelioides)* a candidate for category 2 federal listing and considered rare and endangered in California and elsewhere by CNPS; Santa Clara thornmint (*Acanthomintha lanceolata*), a California endangered species; rock sanicle (*Sanicula saxitilis*), a candidate for category 2 federal listing and a California rare species; and, harebell (*Campanula exiqua*), and Brewers clarkia (*Clarkia breweri*), both listed on CNPS list 4 because of limited distribution. Table 2-2 gives a listing of special status species potentially occurring on the Alameda Watershed.

REGULATORY FRAMEWORK

Special Status Species

Special status species include those listed by the federal or state governments as endangered, threatened, rare, or candidate for listing, or listed by the California Native Plant Society (CNPS) as rare or endangered. These species have varying degrees of legal protection under both Federal and California Endangered Species Acts (FESA and CESA), and the California Environmental Quality Act (CEQA). The United States Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) share responsibility for protection of biological resources in the watershed, although the San Francisco Water Department (SFWD) has full responsibility for their management. Under separate state (CEQA) and federal (NEPA) legislation, each agency conducts a detailed review of the environmental documentation for any project that could affect a special status plant or animal species. It is the responsibility of SFWD to prepare these documents in the event of any action having significant environmental impacts in the watershed.

TABLE 2-2: SPECIAL STATUS PLANT SPECIES REPORTED FROM THE VICINITY OF THE ALAMEDA WATERSHED

Scientific Name	Common Name	Status* Fed/State/CNPS ****,NA	Habitat	Survey Period	Comments
PLANTS					
Acanthomintha lanceolata	Santa Clara thorn mint	F-/S-/List 4	Chaparral, shale scree	March-June	Type Habitat-Calaveras[2]
Balsamorhiza macrolepis var. macrolepis	Balsamroot	F-/S-/ List 3	Cismontane woodland, grassland	March-June	Interior slopes near SF Bay
Calochortus umbellatus	Oakland star tulip	F-/S-/4	Chap., Con. Forest.,Ultramafic	March-May	In Mt.Hamilton Range[2]
Campanula sharsmithiae	Sharsmith's harebell	FC2/S-/1B	Chaparral, ultramafic talus	May-June ?	Mt. Hamilton Range
Cirsium fontinale var campylon	Mt. Hamilton thistle	FC2/S-/1B	Ultramafic seeps, sandy streams	May-July	Mt. Hamilton Range[2]
Cirsium walkerianum	Alameda County thistle	F-/S-/List 4	Broad-leaved Upland forest	June-July	*C. quercetorum* [3]
Clarkia breweri	Brewer's clarkia	F-/S-/List 4	Chaparral, shale talus	April-May	Mt.Hamilton Range[2]
Clarkia franciscana	Presidio clarkia	FC1/SE/1B	Coastal Scrub, Grassland (ultrama)	May-July	Alameda County[4]
Collomia diversifolia	Serpentine collomia	F-/S-/List 4	Serpentine seeps, streams	May-June	Red Mountains[2]
Coreopsis hamiltonii	Mt. Hamilton coreopsis	FC2/S-/1B	Steep, shale talus, woodland	March-May	Mt.Hamilton Range[2]
Delphinium californicum ssp. interius	Inner Co. Range Larkspur	FC2/S-/List 3	Dry ravines	April-June	Mt.Hamilton Range[2]
Dirca occidentalis	western leatherwood	F-/S-/List 4	Broad-leaved Upland forest, Chap.	Jan-March	Alameda, Santa Clara Co [4]
Dudleya setchellii	Santa Clara Valley dudleya	FC1/S-/1B	Ultramafic grasslands	May-June	Outside of range
Eriogonum luteolum var caninum	Tiburon buckwheat	FC3c/S-/4	Ultramafic grasslands and chaparral	June-Sept	Alameda, Santa Clara Co [4]
Eriophyllum jepsonii	Jepson's woolly sunflower	F-/S-/List 4	Coastal scrub	April-June	Alameda, Santa Clara Co [4]
Eryngium aristulatum var. hooveri	Hoover's button-celery	FC2/S-/1B	Vernal pools	May-Aug	San Franciscisco Bay Area[1]
Fritillaria agrestis	stinkbells	FC3c/S-/4	Cismontane woodland, grassland	March-April	Alameda, Santa Clara Co [4]
Fritillaria falcata	talus fritillary	FC2/S-/1B	Chaparral, woodland, on talus	March-May	Alameda, Santa Clara Co [4]
Fritillaria liliacea	fragrant fritillary	FC2/S-/1B	Ultramafic scrub and grassland	Feb-April	Alameda, Santa Clara Co [4]
Lasthenia conjugens	Contra Costa goldfields	FC1/S-/1B	Moist grasslands, vernal pools	April-May	Alameda, Santa Clara Co [4]
Lepidium latipes	dwarf pepper-grass	F-/S-/List 4	Ultramafic or alkaline grassland	March-May	Widely distributed in small areas
Malacothamnus arcuatus	arcuate bush mallow	F-/S-/List 4	Chaparral	April-July	Santa Clara Co [4]
Malacothamnus hallii	Hall's bush mallow	F-/S-/List 4	Chaparral	May-July	Alameda, Santa Clara Co[4]
Perideridia gairdneri	Gairdner's yampah	FC2/S-/1B	Broad-leaved Upland forest, Chap.	June-July	Santa Isabella Valley [2]
Phacelia phacelioides	Mt. Diablo phacelia	FC2/S-/1B	Cismontane woodland, chaparral	April-May	Alameda, Santa Clara Co[4]
Plagiobothrys myosotoides	Forget-me-not popcorn fl.	F-/S-/List 3	Chaparral	April-May	Ridge-top in Mt.Ham.Rn[2]
Quercus lobata	Valley oak	F-/S-/List 4	Widespread on alluvial terraces		ESA 1993,Corelli 1992
Ranunculus lobbii	Lobb's aquatic buttercup	F-/S-/List 4	Ponds, pools, watering holes	Feb-April	Alameda, Santa Clara Co [3]
Ribes divaricatum var. pubiflorum	straggly gooseberry	F-/S-/List 4	Broad-leaved Upland forest	March-May	Alameda, Santa Clara Co[4]
Sanicula saxitilis	rock sanicle	FC2/SR/1B	Broad-leaved Upland forest, Chap.	May-June	Santa Clara Co [4]
Streptanthus albidus ssp albidus	Metcalf Cyn jewelflower	FC1/S-/1B	Serpentine grassland, barrens	April-June	Santa Clara Co [4]
Streptanthus albidus ssp peramoenus	uncommon jewelflower	FC1/S-/1B	Serpentine grassland, chaparral	April-June	San Francisco Bay Area[1]
Streptanthus callistus	Mt. Hamilton jewelflower	FC2/S-/1B	Shale talus	April-May	Endemic, Arroyo Bayo[2]
Streptanthus hispidus	Mt. Diablo jewelflower	FC2/S-/1B	Grassland	March-June	Endemic, Mt. Diablo[4]

TABLE 2-2: SPECIAL STATUS PLANT SPECIES REPORTED FROM THE VICINITY OF THE ALAMEDA WATERSHED

Scientific Name	Common Name	Status* Fed/State/CNPS ****,NA	Habitat	Survey Period	Comments
Stylocline amphibola	Mt. Diablo cottonweed	F-/S-/List 4	Broad-leaved Upland forest, Chap.	April-May	Alameda Co [4]
Trifolium amoenum	showy Indian clover	FC2/S-/1A	Grasslands	April-June	Alameda, Santa Clara Co [3]
Tropidocarpum capparideum	caper-fruited tropidocarpum	FC2/S-/1A	Alkaline hills, grasslands	March-April	Alameda, Santa Clara Co [4]

KEY:

Federal Listing Categories

U.S. Fish & Wildlife Service

FE=Federal Endangered

FT=Federal Threatened

FC=Federal Candidate

FC1=Candidate info. indicates listing may be appropriate, data on file at present time.

FC2=Candidate info. indicates listing may be approprialte, supporting data not on file.

FC3a=Non-candidate; previous candidate but now believed extinct.

FC3b=Non-candidate; previously candidate but now considered an invalid taxon.

FC3c=Non-candidate; previously a candidate but now not threatened.

State Listing Categories

CE=California Endangered

CT=California Threatened

CR=California Rare

Note: California has also lists species of special concern and they are marked "CSC" but have no legal status except under CEQA.

Private Sector Interest Groups

California Native Plant Society (CNPS) Lists

List 1A=Plants presumed extinct in California

List 1B=Plants rare and endangered in California and elsewhere

List 2=Plants endangered in California, more common elsewhere

List 3=Plants about which more information is needed

List 4=Plants of limited distribution (a "watch list")

References:

[1] CNDDB Rarefind printout Special Plant Element List, August 1991.
[2] Sharsmith, H., Flora of the Mount Hamilton Range of California, California Native Plant Society, No.6, 1982.
[3] Hickman, J. C. [ed.] 1993. The Jepson Manual Higher Plants of California. University of California Press, Berkeley, California.
[4] Smith, J. P. and K. Berg [eds.], Inventory of Rare and Endangered Vascular Plants of California, California Native Plant Society, Sacramento, California, and Schauss, M. and T. Corelli, San Francisco Water Department Wild Pig Survey: Calaveras and San Antonio Reservoir Watersheds, 1992.

SOURCE: Environmental Science Associates, 1993

Because a US Army Corps of Engineers (COE) permit is required for any project proposing to place more than one acre of fill in "waters of the U.S." or wetlands (as "other waters"), the COE will consult with other federal and state resource agencies. If a species listed as endangered or threatened may be affected, the COE as federal lead agency (on the permit) must initiate a formal consultation with the USFWS and/or CDFG, as applicable under federal or state law. Table 2-3 defines the various federal and state protection classifications.

Sections 7 and 10(a) of the Federal Endangered Species Act (16 USC 1531 et seq.) requires formal consultation only for those species currently listed as threatened or endangered. The USFWS recommends candidate species also be considered because they may become listed during the design or construction phases of a project. Section 9 of the Act prohibits the "taking" of listed species. If incidental taking might occur as a result of a project, that is, if individuals of a listed species would be inadvertently harmed, harassed, or collected, or if listed animals would suffer significant habitat modification, consultation with the USFWS is required. A Habitat Conservation Plan may be required to obtain an permit allowing habitat modification.

In addition to providing formal and informal consultation, the CDFG has established the California Natural Diversity Data Base - RareFind (CNDDB), as mentioned above, a program that inventories the State's special status species and also provides information on their current listing status. RareFind also includes information on rare natural communities which are considered rare by CDFG but are, as yet, not regulated by law except CEQA.

The California Native Plant Society (CNPS) publishes and regularly updates the *Inventory of Rare and Endangered Vascular Plants of California* (Smith and Berg 1988) The CNPS gathers information from the CDFG and from amateur and professional botanists throughout the State, and contributes this information to the CNDDB. The Inventory has become the standard reference on California's rare and endangered plants. Plants listed by CNPS on List 1A, 1B, or 2, but not officially listed by the State, nevertheless can receive protection under CEQA; substantial effects to these CNPS-listed species are considered to be significant.

TABLE 2-3: SPECIAL STATUS SPECIES PROTECTION CLASSIFICATION

Federal Status

Endangered	Species in danger of extinction throughout all or significant portion of its range.
Threatened	Species likely to become endangered within foreseeable future throughout all or significant portion of its range.
Category 1	Candidate information now available indicates that listing may be appropriate with supporting data currently on file.
Category 2	Candidate information now available indicates that listing may be appropriate but supporting data is not currently on file.
Category 3a	Non-candidate previously considered candidate but now extinct.
Category 3b	Non-candidate previously considered candidate but now invalid taxonomically.
Category 3c	Non-candidate previously considered candidate but now too widespread or not threatened.

California State Status

Endangered	Species whose continued existence in California is jeopardized.
Threatened	Species, although not presently threatened with extinction, which is likely to become endangered in the foreseeable future.

CNPS

List 1 A. Plants presumed extinct in California.
B. Plants are rare and endangered in California and elsewhere.

List 2 Plants are endangered in California, but more common elsewhere.

List 3 Plants about with more information is needed.

List 4 Plants of limited distribution (a "watch" list).

SOURCE: Environmental Science Associates, Inc., 1993.

Wetlands and Riparian Protection

Section 404 of the Federal Clean Water Act regulates discharge of fill material into "waters of the United States," which include wetlands. The U.S. Army Corps of Engineers (COE) is responsible for issuance of a permit for any project which proposes filling of between one and ten acres of wetlands. Filling of less than one acre of isolated or "above the headwaters" wetlands requires no formal notification of the COE or COE Permit, filling between one and ten acres would be permitted under a Department of the Army Nationwide Permit #26, provided certain conditions are met including notification in writing of COE that the discharge was occurring accompanied by a preliminary delineation of the wetland to receive the fill. Minor fills of less than 25 cubic yards and minor dredging of less than 20 cubic yards of material may be permitted under Nationwide Permits #18 and 19, respectively, in any "waters of the U.S." The Environmental Protection Agency (EPA) has an oversight role, and through an involved process, can override a decision by the COE to issue a permit. Certain activities such as normal farming practices, emergency reconstruction of existing structures, and construction of irrigation ditches are exempt from Section 404 permit requirements. The Corps has recently proposed forty new Nationwide permits authorizing various activities in the nation's waters and wetlands. See Appendix A for more information on COE permitting requirements.

In addition to COE regulatory authority over "Waters of the United States," CDFG has authority to oversee work in streams pursuant to Fish and Game Code Sections 1601 to 1603. A landowner or agency proposing to substantially divert the natural flow of a stream, substantially alter its bed or bank, or use any material from the streambed, must first enter into a "Streambed Alteration Agreement" with CDFG. The CDFG, while able to impose reasonable conditions on the agreement, may not decline to enter into an agreement.

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ALAMEDA WATERSHED
NATURAL COMMUNITY TABLES

COMMUNITY NAME:	**MIXED EVERGREEN FOREST/COAST LIVE OAK WOODLAND**
WILDLIFE HABITAT	MIXED EVERGREEN FOREST/COASTAL OAK WOOLAND
COMMUNITY MAP NUMBER:	**1**

Structural Aspects:

A fairly dense woodland that in its dense structure is more a forest. The Holland communities of the combined element name describe the species mix more closely with coast live oak forest having a more restricted species list.

Predominant Terrain Features:

Grows on steep northeast-facing slopes above San Antonio and Calaveras Reservoirs and to the east of both reservoirs in Arroyo Hondo and along Alameda Creek above the dam.

Predominant Climatic Conditions:

Mediterranean climate of central California, modified by slope which decreases evapotranspiration by shading the vegetation during the late afternoon.

Elevation Range:

Usual range from 200 to 3000 feet in the outer coast ranges and on north-facing slopes of the inner coast ranges. On the Alameda watershed this natural community occurs from 350 to 2000 feet in elevation.

Characteristic Plant Species:

Coast live oak	*Quercus agrifolia*
California bay or laurel	*Umbellularia californica*
California buckeye	*Aesculus californica*
Madrone	*Arbutus menziesii*
Western poison oak	*Toxicodendron diversilobum*

Associated Plant Species:

Big-leaf maple	*Acer macrophyllum*
Toyon	*Heteromeles arbutifolia*
California coffeeberry	*Rhamnus californica*
Ripgut brome	*Bromus diandrus*
Big-leaf maple	*Acer macrophyllum*
Indian warrior	*Pedicularis densiflora*
Yerba buena	*Satureja douglasii*
Sticky monkey-flower	*Mimulus aurantiacus*
White-flowered hawkweed	*Hieracium albiflorum*
Snowberry	*Symphoricarpus albus* var *laevigatus*
Houndstongue	*Cynoglossum grande*
Chickweed	*Stellaria media*
Western leatherwood	*Dirca occidentalis*

Potential Special Status Plant Species:

FC2/S-/List 1B	Gairdner's yampah	*Perideridia gairdneri*
FC2/SR/List1B	Rock sanicle	*Sanicula saxitilis*
F-/S-/List 4	Western leatherwood	*Dirca occidentalis*
F-/S-/List 4	Mt. Diablo Cottonweed	*Stylocline amphibola*
FC3c/S-/Lst 4	Stinkbells	*Fritillaria agrestis*
F-/S-/List 4	Alameda County thistle	*Cirsium walkerianum*
F-/S-/List 4	Straggly gooseberry	*Ribes divaricatum* var. *pubiflorum*

Key Wildlife Aspects:

- Wildlife habitat value varies within the mapping unit, and increases proportionally with structural diversity and plant species diversity. Habitat value tends to increase with maturity.
- Oak woodlands interdigitate with a wide variety of other habitat types, enriching the intrinsic habitat values.
- Mixed stands (species composition, age) provide overall diversity of species and physical structure.
- Acorns provide a major food resource.
- Used by a broad variety of wildlife species, including both narrowly adapted and widely adapted bird species.

Associated Animal Species:

California newt	*Taricha torosa*
Rough-skinned newt	*Taricha granulosa*
Ensatina	*Ensatina eschscholtsii*
Black salamander	*Aneides flavipunctatus*
Arboreal salamander	*Aneides lugubris*
California slender salamander	*Batrachoseps attenuatus*
Western fence lizard	*Sceloporus occidentalis*
Pacific tree frog	*Hyla regilla*
Western toad	*Bufo boreas*
Coyote	*Canis latrans*
Bobcat	*Lynx rufus*
Gray fox	*Urocyon cinereoargenteus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon	*Procyon lotor*
Shrew-mole	*Neeurotrichus gibbsii*
Striped skunk	*Mephitis mephitis*
Spotted skunk	*Spilogale putorius*
Long-tailed weasel	*Mustela frenata*
Gray squirrel	*Sciurus griseus*
Great horned owl	*Bubo virginianus*
Acorn woodpecker	*Melanerpes formicivorus*
Northern flicker	*Colaptes auratus*
Ash-throated flycatcher	*Myiarchus cinerascens*

Associated Animal Species (Continued):

Scrub jay	*Aphelocoma coerulescens*
Plain titmouse	*Parus inornatus*
Dark-eyed junco	*Junco hyemalis*
Turkey vulture	*Cathartes aura*

Potential Special Status Animal Species:

Status	Occurence	Species	
CFP	R	Black-shouldered kite (nesting)	*Elanus caeruleus*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperii*
CSC	P	Pallid bat	*Antrozous pallidus*
SFP	P	Ringtail	*Bassariscus astutus*

Constraints/Sensitivities:

- Care should be exercised when clearing roadsides in this natural community. No herbicides should be used because this may be habitat for several plant species which are candidates for listing as endangered.
- In areas of California such as the Marin Municipal Water District's watershed, coast live oak, California bay and Douglas fir have invaded grasslands and oak woodlands due to the reduced frequency of fire in the physical environment.
- Oak woodlands have been increasing in density in the last 40 to 60 years according to Griffin (1977) due, in part to the reduction of fire frequency.
- Coast live oak is sensitive to changes in the elevation of soil around the trunk and roots since these changes usually cause soil compaction and an altered infiltration rate. The overall effect may be more or less soil moisture than that to which the tree is habituated. Less moisture causes drought stress and too much moisture may result in the increased growth of water molds in the soil, the erosion of the bark of roots and the eventual death of the root and then the tree.
- Areas with excessive undergrowth and/or downed branches may overburn in controlled fire; high temperatures could cause significant damage to trees, wildlife, propagules, seeds that would survive a less catastrophic burn.
- Most vulnerable to disturbance during the spring nesting and breeding season.
- Trees used as nesting habitat by any birds should not be removed or disturbed during nesting season. Nesting surveys should precede tree removal or clearing.

COMMUNITY NAME:	**VALLEY OAK WOODLAND**
WILDLIFE HABITAT:	VALLEY OAK WOODLAND
COMMUNITY MAP NUMBER:	**2**

Structural Aspects:

This is an open savanna rather than a closed woodland. The trees are large, spreading specimens which reach 50 to 125 feet at maturity. Stands seldom exceed 30 to 40 percent cover in the tree canopy. Grasses such as creeping wildrye form the understory with occasional shrubs.

Predominant Terrain Features:

Found on deep, well-drained alluvial soils, usually valley bottoms (Holland 1986). Large, healthy valley oaks are probably rooted down to permanent water supplies (Griffin 1973). In the Alameda watershed, large specimens of valley oaks occur on low terraces and also along the top of ridges such as Poverty Ridge above Calaveras Reservoir.

Predominant Climatic Conditions:

Mediterranean climate of central California, mild, wet winters and hot, dry summers.

Elevation Range:

Valley oak grows from near sea level to nearly 6000 feet (Griffin and Critchfield 1972). At San Antonio Reservoir valley oak grows between 350 and 600 feet and at Calaveras it goes up to about 2000 feet.

Characteristic Plant Species:

Valley oak	*Quercus lobata*
Western poison oak	*Toxicodendron diversalobum*
Blue wildrye grass	*Elymus triticoides*
Wild oat	*Avena fatua and A. barbata*
Soft chess	*Bromus [mollis] hordeaceous*
Ripgut brome	*Bromus diandrus*

Associated Plant Species:

Blue oak	*Quercus douglasii*
Coast live oak	*Quercus agrifolia*
California coffeeberry	*Rhamnus californica*
Sticky monkey-flower	*Diplacus aurantiacus*
Yerba buena	*Satureja douglasii*
Snowberry	*Symphoricarpus albus* var *laevigatus*
Houndstongue	*Cynoglossum grande*
Chickweed	*Stellaria media*

Potential Special Status Plant Species:

F-/S-/ List 4	Valley oak	*Quercus lobata*
FC2/S-/List 1B	Gairdner's yampah	*Perideridia gairdneri*
FC2/SR/List1B	Rock sanicle	*Sanicula saxitilis*

F-/S-/List 4	Western leatherwood	*Dirca occidentalis*
F-/S-/List 4	Mt. Diablo Cottonweed	*Stylocline amphibola*
FC3c/S-/Lst 4	Stinkbells	*Fritillaria agrestis*
F-/S-/List 4	Alameda County thistle	*Cirsium walkerianum*
F-/S-/List 4	Straggly gooseberry	*Ribes divaricatum* var. *pubiflorum*

Key Wildlife Aspects:

- Habitat structure is open savannah rather than closed woodland. Understory is also open, with low-growing grasses and herbs.
- Oak woodlands interdigitate with a wide variety of other habitat types, enriching their intrinsic habitat values.
- Important habitat for neotropical migratory birds.
- Acorns provide a major food resource.
- Large trunks and branches with dead ends and cavities are important habitat for hole nesters. Big trees used by raptors and other large-bodied birds.
- Used by a broad variety of wildlife species, including both narrowly adapted and widely adapted bird species.

Associated Animal Species:

California newt	*Taricha torosa*
Rough-skinned newt	*Taricha granulosa*
Ensatina	*Ensatina eschscholtzi*
Black salamander	*Aneides flavipunctatus*
Arboreal salamander	*Aneides lugubris*
California slender salamander	*Batrachoseps attenuatus*
Western fence lizard	*Sceloporus occidentalis*
Pacific tree frog	*Hyla regilla*
Western toad	*Bufo boreas*
Coyote	*Canis latrans*
Bobcat	*Lynx rufus*
Gray fox	*Urocyon cinereoargenteus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon	*Procyon lotor*
Shrew-mole	*Neeurotrichus gibbsii*
Striped skunk	*Mephitis mephitis*
Spotted skunk	*Spilogale putorius*
Long-tailed weasel	*Mustela frenata*
Gray squirrel	*Sciurus griseus*
Great horned owl	*Bubo virginianus*
Acorn woodpecker	*Melanerpes formicivorus*
Northern flicker	*Colaptes auratus*
Ash-throated flycatcher	*Myiarchus cinerascens*

Associated Animal Species: (Continued)

Scrub jay	*Aphelocoma coerulescens*
Plain titmouse	*Parus inornatus*
Dark-eyed junco	*Junco hyemalis*
Turkey vulture	*Cathartes aura*
California quail	*Callipepla californica*

Potential Special Status Animal Species:

Status	Occurence	Species	
CFP	R	Black-shouldered kite (nesting)	*Elanus caeruleus*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperii*
CSC	P	Pallid bat	*Antrozous pallidus*
CFP	P	Ringtail	*Bassariscus astutus*
CSC/FC2	P	California tiger salamander	*Ambystoma californiense*

Constraints/Sensitivities:

- Sudden changes in soil drainage and oxygenation can cause death of root tissue and tree decline.
- Care should be exercised when clearing roadsides in this natural community. No herbicides should be used because this may be habitat for several plant species which are candidates for listing as endangered.
- Reproduction of valley oaks may be limited by a variety of causes.
- Most vulnerable to disturbance during the spring nesting and breeding season.
- Trees used as nesting habitat by any birds should not be removed or disturbed during nesting season. Nesting surveys should precede tree removal or clearing of dead wood.

COMMUNITY NAME: **BLUE OAK WOODLAND**
WILDLIFE HABITAT: **BLUE OAK WOODLAND**
COMMUNITY MAP NUMBER: **3**

Structural Aspects:

Blue oaks average 46 percent of the vegetation cover, coast live oak 21 percent and valley oak 60 percent. The community is named for the blue oak because it has the greatest constancy, 88 percent (Allen et al., 1989). Grows on the northeast facing steeps slopes of Alameda Creek, Arroyo Hondo, and possibly Williams Gulch.

Predominant Terrain Features:

Found on steep slopes with well-drained soils. Frequent fires will favor blue oak (a long-lived, stump sprouter) over foothill pine (Holland 1986).

Predominant Climatic Conditions:

Mediterranean climate of central California, mild, wet winters and hot, dry summers.

Elevation Range:

Blue oak grows from near sea level to 3000-4000 feet (Holland 1986)). At San Antonio Reservoir blue oak grows between 350 and 600 feet, and at Calaveras it goes up to about 2000 feet.

Characteristic Plant Species:

Blue oak	*Quercus douglasii*
Wild oat	*Avena fatua and A. barbata*
Soft chess	*Bromus [mollis] hordeaceous*
Ripgut brome	*Bromus diandrus*
Purple needlegrass	*Nassella (Stipa) pulchra*
Coast live oak	*Quercus agrifolia*
Oaks	*Quercus lobata, Q. kellogii, Q. wislizenii*

Associated Plant Species:

Western poison oak	*Toxicodendron diversailobum*
Foothill pine	*Pinus sabiniana*
Manzanita	*Arctostaphylos glandulosa*
California buckeye	*Aesculus californicus*
Ceanothus	*Ceanothus thyrsiflorus*

Potential Special Status Plant Species:

FC2/S-/List 1B	Gairdner's yampah	*Perideridia gairdneri*
FC2/SR/List1B	Rock sanicle	*Sanicula saxitilis*
F-/S-/List 4	Western leatherwood	*Dirca occidentalis*
F-/S-/List 4	Mt. Diablo Cottonweed	*Stylocline amphibola*
FC3c/S-/Lst 4	Stinkbells	*Fritillaria agrestis*
F-/S-/List 4	Alameda County thistle	*Cirsium walkerianum*
F-/S-/List 4	Straggly gooseberry	*Ribes divaricatum* var. *pubiflorum*

Key Wildlife Aspects:

- Habitat structure more open, less diverse than Mixed Evergreen/Coast Live Oak Woodland.
- Oak woodlands interdigitate with a wide variety of other habitat types, enriching the intrinsic habitat values.
- Acorns provide a major food resource.
- Used by a broad variety of wildlife species, including both narrowly adapted and widely adapted bird species.

Associated Animal Species:

California newt	*Taricha torosa*
Rough-skinned newt	*Taricha granulosa*
Ensatina	*Ensatina eschscholtzi*
Black salamander	*Aneides flavipunctatus*
Arboreal salamander	*Aneides lugubris*
California slender salamander	*Batrachoseps attenuatus*
Western fence lizard	*Sceloporus occidentalis*
Pacific tree frog	*Hyla rigilla*
Western toad	*Bufo boreas*
Coyote	*Canis latrans*
Bobcat	*Lynx rufus*
Gray fox	*Urocyon cinereoargenteus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon	*Procyon lotor*
Shrew-mole	*Neeurotrichus gibbsii*
Striped skunk	*Mephitis mephitis*
Spotted skunk	*Spilogale putorius*
Long-tailed weasel	*Mustela frenata*
Gray squirrel	*Sciurus griseus*
Great horned owl	*Bubo virginianus*
Acorn woodpecker	*Melanerpes formicivorus*
Northern flicker	*Colaptes auratus*
Ash-throated flycatcher	*Myiarchus cinerascens*
Scrub jay	*Aphelocoma coerulescens*
Plain titmouse	*Parus inoratus*
Dark-eyed junco	*Junco hyemalis*
Turkey vulture	*Cathartes aura*
California quail	*Callipepla californica*

Potential Special Status Animal Species:

Status	Occurence	Species	
CSC/SFP	P	Black-shouldered kite (nesting)	*Elanus caeruleus*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperii*
FC2/CSC	P	Pallid bat	*Antrozous pallidus*
SFP	P	Ringtail	*Bassariscus astutus*

Constraints/Sensitivities:

- Care should be exercised when clearing roadsides in this natural community. No herbicides should be used because this may be habitat for several plant species which are candidates for listing as endangered.
- Areas with excessive undergrowth, downed branches may overburn in controlled fire; high temperatures could cause significant damage to trees, wildlife, propagules, seeds that would survive a less catastrophic burn.
- Reproduction of blue oaks may be limited by a variety of causes.
- Most vulnerable to disturbance during the spring nesting and breeding season.
- Trees used as nesting habitat by any birds should not be removed or disturbed during nesting season. Nesting surveys should precede tree removal or clearing.

COMMUNITY NAME: **CENTRAL COAST ARROYO WILLOW RIPARIAN FOREST**
WILDLIFE HABITAT: WILLOW RIPARIAN
COMMUNITY MAP NUMBER: **4**

Structural Aspects:

Arroyo willows are low shrubby trees that often cover an entire water course with an impenetrable thicket. Alders and black willow are trees, the alder growing to considerable height with adequate water and lack of disturbance. All of the species are winter-deciduous.

Predominant Terrain Features:

Grow along low gradient streams that occur in the bottoms of ravines or canyons. Willow often grows where water is ephemeral or at least below the surface for the dryer portions of the year.

Predominant Climatic Conditions:

Arroyo willow grows within the coastal riparian zones.

Elevation Range:

Sea level from 350 to 2000 feet on the Alameda watershed.

Characteristic Plant Species:

Arroyo willow	*Salix lasiolepis*
White alder	*Alnus rhombifolia*
Red alder	*Alnus rubra*

Associated Plant Species:

California bay myrtle	*Myrica californica*
Black willow	*Salix lasiandra*

Potential Special Status Plant Species:

None

Key Wildlife Aspects:

- Open water is important link in Pacific Flyway; adjacent riparian habitats are heavily used by migratory passerines and other birds.
- Reproductive habitat for reptiles, amphibians.
- High biological productivity; provides rich food resource for insect-eating birds and other wildlife; complex trophic relationships; critical component in regional food web. Permanent to seasonal water source for resident wildlife.

Key Wildlife Aspects (Continued):

- Enhances adjacent habitat values.

- Linear configuration functions as protected movement corridor for resident and migratory wildlife.

Associated Animal Species:

California newt	*Taricha torosa*
Rough skinned newt	*Taricha granulosa*
Western toad	*Bufo boreas*
Bobcat	*Lynx rufous*
Gray fox	*Urocyon cinereoargenteus*
Shrew-mole	*Neeurotrichus gibsii*
Broad-footed mole	*Scapanus latimanus*
Striped skunk	*Mephitis mephitis*
Long-tailed weasel	*Mustela frenata*
Turkey vulture	*Carthartes aura*
Red-shouldered hawk	*Buteo lineatus*
American kestrel	*Falco sparverius*
California quail	*Callipepla californica*
Anna's hummingbird	*Calypte anna*
Rufus hummingbird	*Selasphorus rufus*
Belted kingfisher	*Ceryle alcyon*
Nuttall's woodpecker	*Picoides nuttallii*
Downy woodpecker	*Picoides pubescens*
Black phoebe	*Sayornis nigricans*
Ash-throated flycatcher	*Myiachaus cinerascens*
Bushtit	*Psaltriparus minimus*
Bewick's wren	*Thryomanes bewickii*

Potential Special Status Animal Species:

Status	Occurence	Species	
CSC/FC2	P	Northwestern pond turtle	*Clemmys marmorata marmorata*
FC1/CSC	R	California red-legged frog	*Rana aurora draytonii*
SFP	P	Black-shouldered kite (nesting)	*Elanus caeruleus*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperi*
FC2	P	Ricksecker's water scavenger beetle	*Hydrochara rickeckeri*
CSC/FC2	P	Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*

Constraints/Sensitivities:

- As long as the water table remains relatively stable, arroyo willows are hardy, invasive, weedy colonizing species. Arroyo willow is short-lived and is subject to breakage and limb death.

- Most willow riparian forests would meet the U.S. Army Corps criteria for "wetlands" and a permit would be required to place fill in willow areas for road building, etc.

Constraints/Sensitivities (Continued):

- Removing arroyo willow riparian forest may require a Stream Alteration Agreement with California Department of Fish and Game. DFG cannot deny this "permit" but may put mitigation requirements on the agreement.

- If grazing is considered an appropriate use in grassland areas, the wetland/riparian forests should be fenced as exclosures to prevent the animals from trampling and browsing the vegetation.

- These and other wetlands are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.

- If officially listed, FC species would be protected by Federal Endangered Species Act; other resident species are protected to varying degrees by this and other state and federal statutes. Seasonal survey work for sensitive wildlife species should be done in all wetland areas to prevent inadvertent take.

- Vulnerable to filling, sedimentation, decreased water quality.

- Shoreline habitats are sensitive to human use-trampling, litter, disturbance of feeding, resting, and nesting habitat.

- Introduction of exotic aquatic wildlife (e.g., bullfrog) can be detrimental to native reptile and amphibian populations.

- Mitigation for loss is difficult to achieve successfully; restoration of historic habitat is preferred to creation of new wetlands or enhancement of existing wetlands.

- Most vulnerable to disturbance during the spring - early summer nesting and breeding season, and during fall migration.

- May be adversely affected by reservoir drawdown, particularly in the spring - early summer nesting and breeding season.

COMMUNITY NAME: **CENTRAL COAST LIVE OAK RIPARIAN FOREST**
WILDLIFE HABITAT: COAST LIVE OAK RIPARIAN FOREST
COMMUNITY MAP NUMBER: **5**

Structural Aspects:

A low, evergreen sclerophyllous riparian forest, usually with an open appearance. Coast live oak dominates and often there is an open understory with grasses covering the ground.

Predominant Terrain Features:

In canyon bottoms and floodplains.

Predominant Climatic Conditions:

Locally, this community occurs on the drier, outer floodplains.

Elevation Range:

350 to 1000 feet on the watershed.

Characteristic Plant Species:

Coast live oak	*Quercus agrifolia*
Western poison oak	*Toxicodendron diversilobum*
California blackberry	*Rubus ursinus*
Valley oak	*Quercus lobata*

Associated Plant Species:

Mugwort	*Artemisia douglasiana*
Coyote brush	*Baccharis pilularis var. consanguinea*
Snowberry	*Symphoricarpos mollis*
Mexican elderberry	*Sambucus mexicanus*
Wild oats	*Avena fatua*

Potential Special Status Plant Species:

None

Key Wildlife Aspects:

- Wildlife habitat value varies within the mapping unit, and increases proportionally with structural diversity and plant species diversity. Habitat value tends to increase with maturity.
- Habitat values are largely the same as those of Mixed Evergreen Forest/Coast Live Oak, with the additional attribute of seasonal water and the physical relief of an incised streambed.
- Habitat for a wide variety of wildlife, including unique species.

Key Wildlife Aspects: (Continued)

- Open water of reservoirs is important link in Pacific Flyway; adjacent riparian habitats are heavily used by migratory passerines and other birds.
- Reproductive habitat for reptiles, amphibians.
- Enhanced biological productivity; provides good food resource for insect-eating birds and other wildlife; complex trophic relationships; important component in regional food web.
- Seasonal water source for resident wildlife.
- Enhances adjacent habitat values.
- Linear configuration functions as protected movement corridor for resident and migratory wildlife.

Associated Animal Species:

California newt	*Taricha torosa*
Rough-skinned newt	*Taricha granulosa*
Ensatina	*Ensatina eschscholtzi*
Black salamander	*Aneides flavipunctatus*
Arboreal salamander	*Aneides lugubris*
California slender salamander	*Batrachoseps attenuatus*
Western fence lizard	*Sceloporus occidentalis*
Pacific tree frog	*Hyla regilla*
Western toad	*Bufo boreas*
Coyote	*Canis latrans*
Bobcat	*Lynx rufus*
Gray fox	*Urocyon cinereoargenteus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon	*Procyon lotor*
Shrew-mole	*Neeurotrichus gibbsii*
Striped skunk	*Mephitis mephitis*
Long-tailed weasel	*Mustela frenata*
Gray squirrel	*Sciurus griseus*
Great horned owl	*Bubo virginianus*
Acorn woodpecker	*Melanerpes formicivorus*
Northern flicker	*Colaptes auratus*
Ash-throated flycatcher	*Myiarchus cinerascens*
Scrub jay	*Aphelocoma coerulescens*
Plain titmouse	*Parus inoratus*
Dark-eyed junco	*Junco hyemalis*
Turkey vulture	*Cathartes aura*

Potential Special Status Animal Species:

Status	Occurence	Species	
CFP	P	Black-shouldered kite	*Elanus caeruleus*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperi*
CSC	P	Pallid bat	*Antrozous pallidus*
CFP	P	Ringtail	*Bassariscus astutus*

Constraints/Sensitivities:

- Removal of riparian forest vegetation or making bank alterations will always require a Stream Alteration Agreement with California Department of Fish and Game. Usually obtaining this agreement requires mitigation or compensation, in kind, for the impacts.

- If grazing is considered an appropriate use in grassland areas, the wetland/riparian forests should be fenced as exclosures to prevent the animals from trampling and browsing the vegetation.

- Care should be exercised when clearing roadsides in this natural community. No herbicides should be used because this may be habitat for several plant species which are candidates for listing as endangered.

- If any road repairs must be made leaving a bank without vegetation, care must be taken to re-seed with species that occur locally. Do not leave slopes unseeded as weedy species (such as pampas grass) may establish. Monitor any work for several years.

- May contain wetlands that are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.

- May support populations of unique and sensitive species.

- Vulnerable to filling, sedimentation, decreased water quality.

- Most vulnerable to disturbance during the spring - early summer nesting and breeding season, and fall migration.

COMMUNITY NAME: **WHITE ALDER RIPARIAN FOREST**
WILDLIFE HABITAT: WHITE ALDER RIPARIAN FOREST
COMMUNITY MAP NUMBER: **6**

Structural Aspects:

Trees are a mixture of tall and shrubby, winter deciduous forest that forms a canopy that is dense in areas and open in others. Under dense canopy there is little understory but in open areas sedges, willows, elderberry and ferns are supported. In the canyon bottom of Arroyo Hondo and Alameda Creek there are stands of this community interspersed with Sycamore Alluvial Woodland.

Predominant Terrain Features:

Usually bottom of an incised stream, often freeflowing, although in the case of Arroyo Hondo the stream has been dammed downstream of the White Alder Riparian Forest.

Predominant Climatic Conditions:

May occur in an area of low summer precipitation but requires a perennial stream course.

Elevation Range:

Near sea level to 6000 feet. In the stream courses of the Alameda watershed there may be a mix of white alder and red alder (*Alnus rubra*) as this is the common alder near the Pacific and up to 3000 feet. Corelli (1991) and Sharsmith (1982) mention only white alder.

Characteristic Plant Species:

White alder	*Alnus rhombifolia*
Big-leaf maple	*Acer macrophyllum*
Red alder	*Alnus rubra*

Associated Plant Species:

Arroyo willow	*Salix lasiolepis*
Elderberry	*Sambucus mexicanus*
Sword fern	*Polystichum munitum*
California sycamore	*Platanus racemosa*
Sedge	*Carex* sp
Mosquito bills	*Dodecatheon hendersonii*
California wild rose	*Rosa californica*
Woodland star	*Lithophragma* sp.

Special Status Plant Species:

None

Key Wildlife Aspects (Continued):

- Enhances adjacent habitat values.
- Linear configuration functions as protected movement corridor for resident and migratory wildlife.

Associated Animal Species:

California newt	*Taricha torosa*
Rough skinned newt	*Taricha granulosa*
Western toad	*Bufo boreas*
Bobcat	*Lynx rufous*
Gray fox	*Urocyon cinereoargenteus*
Shrew-mole	*Neeurotrichus gibsii*
Broad-footed mole	*Scapanus latimanus*
Striped skunk	*Mephitis mephitis*
Long-tailed weasel	*Mustela frenata*
Turkey vulture	*Carthartes aura*
Red-shouldered hawk	*Buteo lineatus*
American kestrel	*Falco sparverius*
California quail	*Callipepla californica*
Anna's hummingbird	*Calypte anna*
Rufus hummingbird	*Selasphorus rufus*
Belted kingfisher	*Ceryle alcyon*
Nuttall's woodpecker	*Picoides nuttallii*
Downy woodpecker	*Picoides pubescens*
Black phoebe	*Sayornis nigricans*
Ash-throated flycatcher	*Myiachaus cinerascens*
Bushtit	*Psaltriparus minimus*
Bewick's wren	*Thryomanes bewickii*

Potential Special Status Animal Species:

Status	Occurence	Species	
CSC/FC2	P	Northwestern pond turtle	*Clemmys marmorata marmorata*
FC1/CSC	R	California red-legged frog	*Rana aurora draytonii*
SFP	P	Black-shouldered kite (nesting)	*Elanus caeruleus*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperi*
FC2	P	Ricksecker's water scavenger beetle	*Hydrochara rickeckeri*
CSC/FC2	P	Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*

Constraints/Sensitivities:

- As long as the water table remains relatively stable, arroyo willows are hardy, invasive, weedy colonizing species. Arroyo willow is short-lived and is subject to breakage and limb death.
- Most willow riparian forests would meet the U.S. Army Corps criteria for "wetlands" and a permit would be required to place fill in willow areas for road building, etc.

Constraints/Sensitivities (Continued):

- Removing arroyo willow riparian forest may require a Stream Alteration Agreement with California Department of Fish and Game. DFG cannot deny this "permit" but may put mitigation requirements on the agreement.

- If grazing is considered an appropriate use in grassland areas, the wetland/riparian forests should be fenced as exclosures to prevent the animals from trampling and browsing the vegetation.

- These and other wetlands are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.

- If officially listed, FC species would be protected by Federal Endangered Species Act; other resident species are protected to varying degrees by this and other state and federal statutes. Seasonal survey work for sensitive wildlife species should be done in all wetland areas to prevent inadvertent take.

- Vulnerable to filling, sedimentation, decreased water quality.

- Shoreline habitats are sensitive to human use-trampling, litter, disturbance of feeding, resting, and nesting habitat.

- Introduction of exotic aquatic wildlife (e.g., bullfrog) can be detrimental to native reptile and amphibian populations.

- Mitigation for loss is difficult to achieve successfully; restoration of historic habitat is preferred to creation of new wetlands or enhancement of existing wetlands.

- Most vulnerable to disturbance during the spring - early summer nesting and breeding season, and during fall migration.

- May be adversely affected by reservoir drawdown, particularly in the spring - early summer nesting and breeding season.

COMMUNITY NAME: **CENTRAL COAST LIVE OAK RIPARIAN FOREST**
WILDLIFE HABITAT: COAST LIVE OAK RIPARIAN FOREST
COMMUNITY MAP NUMBER: **5**

Structural Aspects:

A low, evergreen sclerophyllous riparian forest, usually with an open appearance. Coast live oak dominates and often there is an open understory with grasses covering the ground.

Predominant Terrain Features:

In canyon bottoms and floodplains.

Predominant Climatic Conditions:

Locally, this community occurs on the drier, outer floodplains.

Elevation Range:

350 to 1000 feet on the watershed.

Characteristic Plant Species:

Coast live oak	*Quercus agrifolia*
Western poison oak	*Toxicodendron diversilobum*
California blackberry	*Rubus ursinus*
Valley oak	*Quercus lobata*

Associated Plant Species:

Mugwort	*Artemisia douglasiana*
Coyote brush	*Baccharis pilularis var. consanguinea*
Snowberry	*Symphoricarpos mollis*
Mexican elderberry	*Sambucus mexicanus*
Wild oats	*Avena fatua*

Potential Special Status Plant Species:

None

Key Wildlife Aspects:

- Wildlife habitat value varies within the mapping unit, and increases proportionally with structural diversity and plant species diversity. Habitat value tends to increase with maturity.

- Habitat values are largely the same as those of Mixed Evergreen Forest/Coast Live Oak, with the additional attribute of seasonal water and the physical relief of an incised streambed.

- Habitat for a wide variety of wildlife, including unique species.

Key Wildlife Aspects: (Continued)

- Open water of reservoirs is important link in Pacific Flyway; adjacent riparian habitats are heavily used by migratory passerines and other birds.
- Reproductive habitat for reptiles, amphibians.
- Enhanced biological productivity; provides good food resource for insect-eating birds and other wildlife; complex trophic relationships; important component in regional food web.
- Seasonal water source for resident wildlife.
- Enhances adjacent habitat values.
- Linear configuration functions as protected movement corridor for resident and migratory wildlife.

Associated Animal Species:

California newt	*Taricha torosa*
Rough-skinned newt	*Taricha granulosa*
Ensatina	*Ensatina eschscholtzi*
Black salamander	*Aneides flavipunctatus*
Arboreal salamander	*Aneides lugubris*
California slender salamander	*Batrachoseps attenuatus*
Western fence lizard	*Sceloporus occidentalis*
Pacific tree frog	*Hyla regilla*
Western toad	*Bufo boreas*
Coyote	*Canis latrans*
Bobcat	*Lynx rufus*
Gray fox	*Urocyon cinereoargenteus*
Black-tailed deer	*Odocoileus hemionus*
Raccoon	*Procyon lotor*
Shrew-mole	*Neeurotrichus gibbsii*
Striped skunk	*Mephitis mephitis*
Long-tailed weasel	*Mustela frenata*
Gray squirrel	*Sciurus griseus*
Great horned owl	*Bubo virginianus*
Acorn woodpecker	*Melanerpes formicivorus*
Northern flicker	*Colaptes auratus*
Ash-throated flycatcher	*Myiarchus cinerascens*
Scrub jay	*Aphelocoma coerulescens*
Plain titmouse	*Parus inoratus*
Dark-eyed junco	*Junco hyemalis*
Turkey vulture	*Cathartes aura*

Potential Special Status Animal Species:

Status	Occurence	Species	
CFP	P	Black-shouldered kite	*Elanus caeruleus*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperi*
CSC	P	Pallid bat	*Antrozous pallidus*
CFP	P	Ringtail	*Bassariscus astutus*

Constraints/Sensitivities:

- Removal of riparian forest vegetation or making bank alterations will always require a Stream Alteration Agreement with California Department of Fish and Game. Usually obtaining this agreement requires mitigation or compensation, in kind, for the impacts.

- If grazing is considered an appropriate use in grassland areas, the wetland/riparian forests should be fenced as exclosures to prevent the animals from trampling and browsing the vegetation.

- Care should be exercised when clearing roadsides in this natural community. No herbicides should be used because this may be habitat for several plant species which are candidates for listing as endangered.

- If any road repairs must be made leaving a bank without vegetation, care must be taken to re-seed with species that occur locally. Do not leave slopes unseeded as weedy species (such as pampas grass) may establish. Monitor any work for several years.

- May contain wetlands that are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.

- May support populations of unique and sensitive species.

- Vulnerable to filling, sedimentation, decreased water quality.

- Most vulnerable to disturbance during the spring - early summer nesting and breeding season, and fall migration.

Special Status Animal Species:

Status	Occurrence	Species	
CSC/FC2	P	Northwestern pond turtle	*Clemmys marmorata marmorata*
FC1/CSC	P	California red-legged frog	*Rana aurora draytonii*
FC2/CSC	P	Foothill yellow-legged frog	*Rana boylii*
CSC	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	P	Cooper's hawk (nesting)	*Accipiter cooperi*
CFP	P	Ringtail	*Bassariscus astutus*

Constraints/Sensitivities:

- White alders are colonizing species, moving into new mineral soil deposits very early. The alder has nodules on its roots that house nitrogen fixing bacteria and, thus, the tree can thrive in a- nitrogen poor environment. It may be less competitive in a nitrogen rich stream carrying runoff from grazing operations.

- If grazing is considered an appropriate use in grassland areas, the wetland/riparian forests should be fenced as exclosures to prevent the animals from trampling and browsing the vegetation.

- May contain wetlands that are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.

- May support populations of unique and sensitive species; habitat should be surveyed to prevent inadvertent take.

- Vulnerable to filling, sedimentation, decreased water quality.

- Shoreline habitats are sensitive to human use-trampling, litter, disturbance of feeding, resting, and nesting habitat.

- Mitigation for loss is difficult to achieve successfully; restoration of historic habitat is preferred to creation of new wetlands or enhancement of existing wetlands.

- Most vulnerable to disturbance during the spring - early summer nesting and breeding season, and fall migration.

- May be adversely affected by reservoir drawdown, particularly in the spring - early summer nesting and breeding season.

COMMUNITY NAME: SYCAMORE ALLUVIAL WOODLAND
WILDLIFE HABITAT: SYCAMORE ALLUVIAL WOODLAND
COMMUNITY MAP NUMBER: 7

Structural Aspects:

California sycamores are large deciduous trees that grow on rocky, cobbly substrate left on the active terraces or bars, or on recently abandoned terraces of stream courses, and in some cases canyon bottoms with no visible streamflow. Occasionally, such as at the east end of San Antonio Reservoir, the south end of Calaveras Reservoir and along Alameda Creek, Fremont cottonwood and oaks are a part of the community. In the steep canyons on the west side of Calaveras Reservior and in Maguire Creek Canyon, big-leaved maple is added to the community. All of the species are winter-deciduous with the exception of coast live oak.

Predominant Terrain Features:

Grow along low gradient streams that occur in the bottoms of ravines or canyons. Sycamore often grows where water is ephemeral or at least below the surface for the dryer portions of the year.

Predominant Climatic Conditions:

California sycamore is widely distributed in inner coast range canyons from the San Francisco Bay Area south to Baja California.

Elevation Range:

300 to 1000 feet in the watershed.

Characteristic Plant Species:

California sycamore	*Platanus racemosa*
California buckeye	*Aesculus californica*

Associated Plant Species:

Fremont cottonwood	*Populus fremontii*
Valley oak	*Quercus lobata*
Arroyo willow	*Salix lasiolepis*
Elderberry	*Sambucus mexicanus*
Big-leaved maple	*Acer macrophylla*
Coast live oak	*Quercus agrifolia*
Snowberry	*Symphoricarpus* sp.

Potential Special Status Plant Species:

None

Key Wildlife Aspects:

- Sycamores are large, deciduous trees, and form a more open and more structurally varied habitat than willow or alder riparian.
- Sycamores are prone to broken branches, which result in abundant nest holes and cavities.
- Open water of reservoirs is important link in Pacific Flyway; adjacent riparian habitats are heavily used by migratory passerines and other birds.
- Reproductive habitat for reptiles, amphibians.
- High biological productivity; provides rich food resource for insect-eating birds and other wildlife; complex trophic relationships; critical component in regional food web. Permanent to seasonal water source for resident wildlife.
- Enhances adjacent habitat values.
- Linear configuration functions as protected movement corridor for resident and migratory wildlife.

Associated Animal Species:

Rough-skinned newt	*Taricha granulosa*
California newt	*Taricha torosa*
Western toad	*Bufo boreas*
Bobcat	*Lynx rufous*
Gray fox	*Urocyon cinereoargenteus*
Shrew-mole	*Neeurotrichus gibsii*
Broad-footed mole	*Scapanus latimanus*
Striped skunk	*Mephitis mephitis*
Spotted skunk	*Spilogale putorius*
Long-tailed weasel	*Mustela frenata*
Turkey vulture	*Carthartes aura*
Red-shouldered hawk	*Buteo lineatus*
American kestrel	*Falco sparverius*
California quail	*Callipepla californica*
Anna's hummingbird	*Calypte anna*
Rufus hummingbird	*Selasphorus rufus*
Belted kingfisher	*Ceryle alcyon*
Nuttall's woodpecker	*Picoides nuttallii*
Downy woodpecker	*Picoides pubescens*
Black phoebe	*Sayornis nigricans*
Ash-throated flycatcher	*Myiarchaus cinerascens*
Bushtit	*Psaltriparus minimus*
Bewick's wren	*Thryomanes bewickii*

20 other Passerine species

ial Status Animal Species:

s	Occurrence	Species	
C	P	Alameda whipsnake	*Masticophis lateralis euryxanthus*
CSC	P	Northwestern pond turtle	*Clemmys marmorata marmorata*
CSC	R	California red-legged frog	*Rana aurora draytonii*
/CSC	R	Foothill yellow-legged frog	*Rana boylii*
/CFP	R	Black-shouldered kite (nesting)	*Elanus caeruleus*
	P	Sharp-shinned hawk (nesting)	*Accipiter striatus*
	P	Cooper's hawk (nesting)	*Accipiter cooperi*

nsitivities:

grazing is considered an appropriate use in grassland areas, the wetland/riparian forests should be enced as exclosures to prevent the animals from trampling and browsing the vegetation.

ay contain wetlands that are protected by a variety of federal and state statutes administered by JSFWS, USA COE, CDFG.

ay support populations of unique and sensitive species; habitat should be surveyed to prevent nadvertent take.

ulnerable to filling, sedimentation, decreased water quality.

Shoreline habitats are sensitive to human use-trampling, litter, disturbance of feeding, resting, and esting habitat.

Mitigation for loss is difficult to achieve successfully; restoration of historic habitat is preferred to reation of new wetlands or enhancement of existing wetlands.

Most vulnerable to disturbance during the spring - early summer nesting and breeding season, and fall migration.

lay be adversely affected by reservoir drawdown, particularly in the spring - early summer nesting and breeding season.

COMMUNITY NAME: **NORTHERN COASTAL SCRUB**
WILDLIFE HABITAT: COASTAL SCRUB
COMMUNITY MAP NUMBER: **8**

Structural Aspects:

Extensive shrubby vegetation varying in height from three to ten feet depending on exposure to wind and solar radiation. The community is open and low in profile. Ferns, bulbs, annual wild flowers and grasses both annual and perennial are found in the openings between the shrubs.

Predominant Terrain Features:

On the tops and both west- and east-facing slopes of ridges but more likely to be on east facing slopes. Found on shallow, rocky soils.

Predominant Climatic Conditions:

Found on exposed sites and associated with and under coast live oak woodlands.

Elevation Range:

200 to 2000 feet.

Characteristic Plant Species:

California sagebrush	*Artemisia californica*
Sticky monkey-flower	*Diplacus aurantiacus*
Western poison oak	*Toxicodendron diversilobum*
Coyote brush	*Baccharis pilularis* var. *consanguinea*

Associated Plant Species:

California fescue	*Festuca californica*
Lupine	*Lupinus ssp.*
California blackberry	*Rubus ursinus*
Bracken fern	*Pteridium aquilinum* var. *pubescens*
Sword fern	*Polystichum munitum*
Elderberry	*Sambucus mexicanus*
California figwort	*Scrophularia californica*
Soap root	*Chlorogalum pomeridianum*

Potential Special Status Plant Species:

F-/S-/ List 4	Jepson's woolly sunflower	*Eriophyllum jepsonii*
F-/S-/ List 4	Santa Clara thornmint	*Acanthomintha lanceolata*

Key Wildlife Aspects:

- Structure is low and open.
- Structural diversity increased by included patches of perennial grassland, prostrate shrubs, and rock outcroppings.
- Abundant fruits, berries, and associated insect populations are important wildlife food resource.

Associated Animal Species:

Northwestern fence lizard	*Sceloporus occidentalis*
California whiptail	*Cnemidophorus tigris*
Brush rabbits	*Sylvilagus bachmani*
Black-tailed hare	*Lepus californicus*
Coyote	*Canis latrans*
Bobcat	*Lynx rufous*
Gray fox	*Urocyon cinereoargenteus*
Vagrant shrew	*Sorex vagrans*
Shrew-mole	*Neeurotrichus gibbsii*
Striped skunk	*Mephitis mephitis*
Pocket gopher	*Thomomys bottae*
California mouse	*Peromyscus californicus*
Scrub jay	*Aphelocoma coerulescens*
Bewicks wren	*Thryomanes bewickii*
Wrentit	*Chamea fasciata*
Brown towhee	*Pipilo fuscus*
Rufous-sided towhee	*Pipilo crissalis*
California quail	*Callipepla californica*
White crowned sparrow	*Zonotrichia leucophrys*
Golden crowned sparrow	*Zonotrichia atricapilla*
Dark-eyed junco	*Junco hyemalis*

Potential Special Status Animal Species:

Status	Occurrence	Species	
FC2/CSC	R	Loggerhead shrike	*Lanius ludovicianus*
FC1/ST	P	Alameda whipsnake	*Masticophis lateralis euryxanthus*
CSC	R	Sharp-shinned hawk (nesting)	*Accipiter striatus*
CSC	R	California horned lizard	*Phrynosoma coronatum frontale*
FC2	P	Coastal western whiptail	*Cnemidophorus tigris multiscutatus*

Associated Animal Species:

Turkey vulture	*Carthartes aura*
California quail	*Callipepla californica*
Wrentit	*Chamaea fasciata*
California thrasher	*Toxostoma redivinum*
Deer mouse (many small mammals)	*Peromyscus maniculatus*
Western fence lizard (many reptiles)	*Sceloporus occidentalis*
Mule deer	*Odoncoileus himionus*

Potential Special Status Animal Species:

Status	Occurrence	Species	
FC2/CSC	P	Loggerhead shrike	*Lanius ludovicianus*
CSC	P	California horned lizard	*Phrynosoma coronatum frontale*

Constraints/Sensitivities:

- Areas with excessive undergrowth and old wood may overburn in controlled fire; high temperatures could cause significant damage to shrubs, wildlife, propagules, and seeds that would survive a less catastrophic burn.

- Most vulnerable to disturbance during the spring nesting and breeding season.

COMMUNITY NAME:	**NORTHERN MIXED CHAPARRAL***
WILDLIFE HABITAT:	NORTHERN MIXED CHAPARRAL
COMMUNITY MAP NUMBER:	**10**

Structural Aspects:

Dense, often impenetrable cover of shrubs ranging from 6 to 20 feet in height with occasional tree species intermixed. The plants are typically deep-rooted (Holland 1986) and there is little or no understory.

Predominant Terrain Features:

On steeply sloping sides of ridges with rocky soil, most scrub/chaparral communities within the Alameda watershed mapped as Northern Coastal Scrub. There may be some areas that would better be listed as Northern Mixed Chaparral.

Predominant Climatic Conditions:

Native to areas with short winter rainy seasons and long, hot dry (late spring, summer and fall) seasons. Probably adapted to repeated fires, to which many species respond by stump sprouting.

Elevation Range:

200 to 3000 feet in the State but between 300 and 2000 within the Alameda watershed.

Characteristic Plant Species:

Manzanita	*Arctostaphylos sp.*
Scrub oak	*Quercus agrifolia, Q. dumosa*
Chamise	*Adenostoma fasciculatum*
Ceanothus	*Ceanothus thyrsiflorus and C. cuneatus*
Coyote brush	*Baccharis pilularis* var. *consanguinea*

Associated Plant Species:

Yerba Santa	*Eriodictyon californicum*
Western poison oak	*Toxicodendron diversilobum*
Oceanspray	*Holodiscus discolor*
Toyon	*Heteromeles arbutifolia*
California buckeye	*Aesculus californica*
Snowberry	*Symphoricarpus mollis*
Holly leaf cherry	*Prunus ilicifolia*
Douglas iris	*Iris douglasii*

* Not mapped

COMMUNITY NAME: **VALLEY NEEDLEGRASS GRASSLAND***
WILDLIFE HABITAT: PERENNIAL GRASSLAND
COMMUNITY MAP NUMBER: **11**

Structural Aspects:

Up to 80 percent of this open grassland is dominated by species of the Valley Needlegrass Grassland.

Predominant Terrain Features:

Unknown if any Valley Needlegrass Grassland occurs on the watershed.

Predominant Climatic Conditions:

Mediterranean, wind-swept location.

Elevation Range:

Unknown

Characteristic Plant Species:

Purple needlegrass	*Nassella [Stipa] pulchra*
California brome	*Bromus carinatus*
Blue wildrye grass	*Elymus glaucus*
Idaho fescue	*Festuca idahoensis*

Associated Plant Species:

Wild oat	*Avena fatua*
Brownie thistle	*Cirsium quercetorum*
Soap root	*Chlorogalum pomeridianum*
California poppy	*Eschscholzia californica*
Agoseris	*Agoseris apargioides* var. *apargioides*
California man-root	*Marah fabaceous*
Soft chess	*Bromus hordeaceus*
Vulpia	*Vulpia myuros* and *V. bromoides*
Squirreltail	*Elymus elymoides*
Mule ears	*Wyethia angustifolia*

Potential Special Status Plant Species:

FC2/S-/List1A	Showy Indian clover	*Trifolium amoenum*
FC1/S-/List 1B	Contra Costa goldfields	*Lasthenia conjugens*

* Not mapped

Key Wildlife Aspects:

- Perennial native grassland has higher forage and habitat value than annual introduced grasslands.
- Hunting territory for resident and migratory raptorial birds.
- Climax community; individual plants may be decades old; fosters development of specialized microhabitats.

Associated Animal Species:

California newt	*Taricha torosa*
Rough-skinned newt	*Taricha granulosa*
Ensatina	*Ensatina eschscholtsii*
Black salamander	*Aneides flavipunctatus*
Western fence lizard	*Sceloporus occidentalis*
Pacific tree frog	*Hyla regilla*
Gopher snake	*Pituophis melanoleucus*
Turkey vulture	*Cathartes aura*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
American kestrel	*Falco sparverius*
Barn owl	*Tyto alba*
Black phoebe	*Sayornnis nigricans*
Western meadowlark	*Sturnella neglecta*
Brewer's blackbird	*Euphagus cyanocephalus*
Pocket gopher	*Thomomys bottae*
California vole	*Microtus californicus*
Black-tailed hare	*Lepus californicus*
Coyote	*Canis latrans*
Bobcat	*Lynx rufous*
Gray fox	*Urocyon cinereoargenteus*
Vagrant shrew	*Sorex vagrans*
Shrew-mole	*Neeurotrichus gibbsii*
Striped skunk	*Mephitis mephitis*
California mouse	*Peromyscus californicus*

Potential Special Status Animal Species:

Status	Occurrence	Species	
FC2	P	Western spadefoot toad	*Scaphiopus hammondi*
FC2/CSC	R	Loggerhead shrike	*Lanius ludovicianus*
CFP	R	Black-shouldered kite (nesting)	*Elanus caeruleus*
FC2/CSC	R	Ferruginous hawk (wintering)	*Buteo regalis*
CSC	R	Prairie falcon	*Falco mexicanus*
FC2/CSC	R	California horned lark	*Eremophila alpestris actia*
CSC/CFP/BEPA	R	Golden eagle (nesting, wintering)	*Aquila chrysaetos*
FC1	P	Callippe siverspot	*Speyeria callippe*
CSC	R	American badger	*Taxidea taxus*
CSC	P	Burrowing owl (nesting)	*Speyotyto cunicularia*

Constraints/Sensitivities:

- Care should be exercised when clearing roadsides within this natural community. No herbicides should be used because this may be habitat for several plant species which are candidates for listing as endangered or food plants of listed or candidate invertebrate species.

- If any road repairs must be made leaving a bank without vegetation, care must be taken to re-seed with species that occur locally. Do not leave slopes unseeded as weedy species (such as pampas grass, broom, and thistle) may establish. Monitor any work for several years.

- Susceptible to grazing, fence-building, grading, clearing, burning; such activities in or near sensitive species occurrences could have significant adverse impacts and legal consequences. This habitat type should be surveyed for all potential sensitive species to prevent inadvertent take.

- Community dominants adapted to periodic fires, although infrequent burning leads to thatch buildup and overburn of species like *Festuca idahoensis*.

- Disturbed areas with exposed mineral soils highly susceptible to invasion by star thistle, artichoke thistle, other aggressive weeds.

- Ground squirrels are an important component of this habitat type, both as a prey animal and as a source of holes that are used by numerous other species. Extensive poisoning of ground squirrels may have direct and indirect adverse impacts on a variety of listed and sensitive species.

- Susceptible to community succession in absence of disturbance (grazing, fire).

COMMUNITY NAME: **SERPENTINE BUNCHGRASS**
WILDLIFE HABITAT: SERPENTINE BARRENS
COMMUNITY MAP NUMBER: **12**

Structural Aspects:

Flat, open grassland, vegetation approximately one to two feet in height. Open to wind and sun. Unknown if any Serpentine Bunchgrass occurs on the Alameda watershed.

Predominant Terrain Features:

Grassland, gently sloping with a west exposure. Serpentine rock outcrops, some trees and shrubs. Coast live oak and toyon. Some plants of community are endemic but most merely benefit from the reduced competition because other species are unable to tolerate the chemical balance in ultramafic rocks and serpentine and serpentinized soils.

Predominant Climatic Conditions:

Mediterranean climate with damp, cold winters and dry, hot summers.

Elevation Range:

Plant distribution dependent on chemical nature of soil or rock and not elevation.

Characteristic Plant Species:

Purple needlegrass	*Nassella [Stipa] pulchra*
Tidy tips	*Layia platyglossa*
Brodiaea	*Brodiaea californica*
Sheep parsnip	*Lomatium macrocarpum*
Hayfield tarweed	*Hemizonia congesta* ssp *luzulifolia*
Yarrow	*Achillea millefolium*
Silver puffs	*Microseris douglasii*
Popcorn flower	*Cryptantha flaccida*

Associated Plant Species:

Ryegrass	*Lolium multiflorum*
Torrey's melic grass	*Melica torreyana*
Junegrass	*Koeleria [crisiata] macrantha*
Plantago	*Plantago erecta*
Golden yarrow	*Eriophyllum confertiflorum*
Blue-eyed grass	*Sisyrinchium bellum*
Calochortus	*Calochortus luteus*
Winecup clarkia	*Clarkia purpurea*
Serpentine linanthus	*Linanthus ambiguus*
Mosquito bills	*Dodecatheon hendersonii*
Western larkspur	*Delphinium herperium*
Royal larkspur	*D. variegatum ssp variegatum*
Owl's clover	*Castilleja [Orthocarpus] densiflora ssp*
Plectritis	*Plectritis ciliosa ssp.*

* Not mapped

COMMUNITY NAME:	**NON-NATIVE GRASSLAND**
WILDLIFE HABITAT:	ANNUAL GRASSLAND
COMMUNITY MAP NUMBER:	**13**

Structural Aspects:

Sparse to dense cover of annual grasses and some perennial wild flowers and a few perennial grasses. Flower heads may be one to two feet high in dry years or eight to ten feet high in moist year.

Predominant Terrain Features:

Grasslands are usually on relatively flat plains and rolling hills of the central valley, coast and foothill ranges. Most of San Antonio Reservoir watershed is non-native grassland and all of the west-facing slopes of Poverty Ridge and Oak Ridge are covered with non-native grassland as is the low valley along the Calaveras Fault line.

Predominant Climatic Conditions:

Average rainfall of 6 to 20 inches, with a growing season of 7 to 11 months. Rain falls in winter to spring with hot, dry summers (Munz 1970).

Elevation Range:

10 to 4000 feet in the State, 200 to 2000 in the watershed.

Characteristic Plant Species:

Wild oat	*Avena fatua* and *A. barbata*
Soft chess	*Bromus [mollis] hordeaceous*
Ripgut grass	*Bromus diandrus*
Fiddleneck	*Amsinckia* sp.
Filaree	*Erodium botrys, E. cicutarium*
Mustard	*Brassica* sp.

Associated Plant Species:

Coast live oak	*Quercus agrifolia*
Coyote brush	*Baccharis pilularis* var *consanguinea*
California poppy	*Eschscholzia californica*
Valley oak	*Quercus lobata*
Johnny-jump-up	*Viola pedunculata*

Potential Special Status Plant Species:

FC2/S-/List 1B	Fragrant fritillary	*Fritillaria liliacea*

Key Wildlife Aspects:

- Hunting territory for resident and migratory raptorial birds, flocking birds.
- Structure, diversity, species composition varies with soils, moisture, exposure.
- Open terrain permits visual hunting, territorial defense.

Associated Animal Species:

Pacific treefrog	*Hyla regilla*
Western fence lizard	*Sceloporus occidentalis*
Gopher snake	*Pituophis melanoleucus*
Western meadowlark	*Sturnella neglecta*
Barn owl	*Tyto alba*
California ground squirrel	*Spermophilus beecheyi*
Botta's pocket gopher	*Thomomys bottae*
California vole	*Microtus californicus*

Potential Special Status Animal Species:

Status	Occurrence	Species	
FC2	P	Western spadefoot toad	*Scaphiopus hammondi*
FC2/CSC	R	Loggerhead shrike	*Lanius ludovicianus*
CFP	R	Black-shouldered kite	*Elanus caeruleus*
FC2/CSC	R	Ferruginous hawk (wintering)	*Buteo regalis*
CSC	R	Prairie falcon	*Falco mexicanus*
CSC	P	American badger	*Taxidea taxus*
FC2/CSC	R	California horned lark	*Eremophilia alpestris actia*
CSC	R	Burrowing owl	*Speotyto cunicularia*
CSC	R	Short-eared owl (nesting)	*Asio flammeus (San Antonio Grasslands)*
CSC/CFP/BEPA	R	Golden eagle	*Aquila chrysaetos*
FC2/CSC	P	California tiger salamander	*Ambystoma californiense*
FC1	P	Callippe silverspot	*Speyeria callippe*
FE/ST	P	San Joaquin kit fox	*Vulpes macrotis mutica*

Constraints/Sensitivities:

- Care should be exercised when clearing roadsides in this natural community. No herbicides should be used because this may be habitat for several plant species which are candidates for listing as endangered.

- If any road repairs must be made leaving a bank without vegetation, care must be taken to re-seed with serpentine-adapted species that occur locally. Do not leave slopes unseeded as weedy species (such as pampas grass) may establish. Monitor any work for several years.

- Pursue a vigorous program for removal of noxious weeds such as the cardoon or wild artichoke (*Cynara Cardunculus*).

- Susceptible to grazing, fence-building, grading, clearing, burning; such activities in or near sensitive species occurrences could have significant adverse impacts and legal consequences. This habitat type should be surveyed for all potential sensitive species to prevent inadvertent take.

- Overgrazed and disturbed areas with exposed mineral soils highly susceptible to invasion by star thistle, artichoke thistle, other aggressive weeds.

- Ground squirrels are an important component of this habitat type, both as a prey animal and as a source of holes that are used by numerous other species. Extensive poisoning of ground squirrels may have direct and indirect adverse impacts on a variety of listed and sensitive species.

- Susceptible to community succession in absence of disturbance (grazing, fire).

COMMUNITY NAME:	**COASTAL AND VALLEY FRESHWATER MARSH**
WILDLIFE HABITAT:	FRESH EMERGENT WETLAND
COMMUNITY MAP NUMBER:	**14**

Structural Aspects:

Dense canopy of grasslike plants which emerge from water, growing with roots wet but stems and leaves in atmosphere. Usually these plants are perennial but winter withering, dying aboveground after storing energy in an underground rhizome that remains alive over winter, sending up new shoots in spring. Some species such as cattails will readily germinate on mud flats of dried reservoirs and marshes. Tules remain alive over winter with old stems dying at different times during the year.

Predominant Terrain Features:

Marshes are flat, developing on sediments accreted at the location of decreased energy in the sediment bearing waters. This is usually a deltaic formation in a reservoir at the place where a watercourse enters the pool.

Predominant Climatic Conditions:

Cool, wet winters and hot, dry summers usually mean that wetlands or freshwater marshes in California alternate between being wet and dry and even the marshes with reliable water supplies are somewhat seasonal.

Elevation Range:

Plants grow relative to water elevation in reservoir or underground watertable. Tules will grow from -3 feet to +1 relative to water level. Cattails grow best when emerged all summer. Each species has slightly different requirements and thus is different from other species.

Characteristic Plant Species:

Sedges	*Carex* 9 spp.
Spikerush	*Eleocharis acicularis, E. macrostachya*
Rush	*Juncus* 6 spp.
Tules	*Scirpus californicus and 4 other species*
Umbrella sedge	*Cyperus* spp.
Cattails	*Typha latifolia* and *T. domingensis*

Associated Plant Species:

Willows	*Salix sp.*
Water grass	*Echinochloa crusgalli*
Arrow head	*Alisma plantago-aquatica*

Special Status Plant Species:

F-/S-/List 4	Lobb's aquatic buttercup	*Ranunculus lobbii*

Key Wildlife Aspects:

- Essential habitat for a wide variety of wildlife, including listed and unique species.
- Open water is important link in Pacific Flyway; adjacent wetland habitats are heavily used by migratory passerines and other birds.
- Reproductive habitat for reptiles, amphibians.
- High biological productivity; provides rich food resource for insect-eating birds and other wildlife; complex trophic relationships; critical component in regional food web.
- Permanent to seasonal water source for resident wildlife.
- Enhances adjacent habitat values.

Associated Animal Species:

Common egret	*Casmerodias albus*
Mallard	*Anas platyrhynchos*
American coot	*Fulica americana*
Red-winged blackbird	*Agelaius phoeniceus*
Marsh wren	*Cistothorus palustris*

Special Status Animal Species:

Status	Occurrence	Species	
FC2/CSC	R	Tricolored blackbird (nesting colonies)	*Agelaius tricolor*
FC1/CSC	R	California red-legged frog	*Rana aurora draytonii*
FC2/CSC	R	Northwestern pond turtle	*Clemmys marmorata marmorata*
SSA	R	Western grebe	*Aechmophorus accidentalis*
SSA	R	Great blue heron (rookery)	*Ardea herodias*
FC2	P	Ricksecker's water scavenger beetle	*Hydrochara rickseckeri*

Constraints/Sensitivities:

- These and other wetlands are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.
- Resident species may be protected to varying degrees by state and federal statutes. Seasonal survey work for sensitive wildlife species should be done in all wetland areas to prevent inadvertent take.
- Vulnerable to filling, sedimentation, decreased water quality.
- Shoreline habitats are sensitive to human use-trampling, litter, disturbance of feeding, resting, and nesting habitat.
- Introduction of exotic aquatic wildlife (e.g., bullfrog) can be detrimental to native reptile and amphibian populations.
- Mitigation for loss is difficult to achieve successfully; restoration of historic habitat is preferred to creation of new wetlands or enhancement of existing wetlands.
- Most vulnerable to disturbance during the spring - early summer nesting and breeding season, and during fall migration.
- May be adversely affected by reservoir drawdown, particularly in the spring - early summer nesting and breeding season.
- Increased populations of corvids (ravens, crows, jays) attracted to picnic areas or other public use areas may be significant threat to grebe nest success.

COMMUNITY NAME: **CULTIVATED**
WILDLIFE HABITAT: **PASTURE**
COMMUNITY MAP NUMBER: **15**

Structural Aspects:

Canopy cover similar to woodland, fruit for animal use as food, and structure for nesting and cover. In row, field crops, or pasture, the habitat is more like open grassland. Small mammals may forage for seeds and find cover; raptors may hunt.

Predominant Terrain Features:

Cultivated areas in Alameda watershed are commercial nurseries and farming operations on the alluvial floodplain of Alameda Creek in the Sunol Valley.

Predominant Climatic Conditions:

Moist, cool winters and hot, dry summers.

Elevation Range:

Sea level to 2000 feet.

Characteristic Plant Types:

Hay
Pasture
Orchards
Golf Course
Nurseries
Vineyards

Special Status Plant Species:

None

Key Wildlife Aspects:

- Values and characteristics depend on the nature and extent of the cultivation. Grazing, dryland farming, hay-cutting have much the same values as annual grassland habitat.
- Cultivated lands near Pleasanton are included in the San Antonio grassland zone.

Associated Animal Species:

Red-tailed hawk	*Buteo jamaicensis*
Botta pocket gopher	*Thomomys bottae*
Mule deer	*Odocoileus hemionus*

Special Status Animal Species:

See San Antonio grassland entry for a list of species that may occur on cultivated lands within that zone.

Constraints/Sensitivities:

- If habitat is adjacent to grassland, and if disturbance is relatively minor, grassland sensitive species may be present.

- Cultivated lands in the San Antonio grassland zones have special sensitivities (see that entry).

COMMUNITY NAME: **POND OR RESERVOIR**
WILDLIFE HABITAT: **LACUSTRINE**
COMMUNITY MAP NUMBER: **16**

Structural Aspects:

Plants float or are submerged under the water's surface.

Predominant Terrain Features:

Reservoirs provide flat but varying elevation of water surface for plants and birds to utilize. Changing water level means that the habitat is always changing. The amount of dissolved oxygen may vary to a small degree. The terrain effects the reservoir the greatest in providing sediment to surface runoff that changes the quality of the water as habitat.

Elevation Range:

San Antonio Reservoir spillway is at 562 feet elevation and Calaveras 779 feet.

Characteristic Plant Species:

Water fern	*Azolla* sp.
Duckweed	*Lemna* spp.
Pondweed	*Potamogeton nodosus, P. pectinatus*
Parrots-feather	*Myriophyllum exalbescens*
Coon-tail	*Myriophyllum verticillatum*

Potential Special Status Plant Species:

F-/S-/List 4	Lobb's aquatic buttercup	*Ranunculus lobbii*

Key Wildlife Aspects (Open Water Zone):

- Open water of large ponds and reservoirs, characterized by absence of emergent vegetation.
- May provide habitat for Aleutian Canada goose (wintering: FT); osprey (nesting: CSC); western grebe (SSA); northwestern pond turtle (FC2, CSC).
- Open water is important link in Pacific Flyway; adjacent wetland habitats are heavily used by migratory passerines and other birds.
- Reproductive habitat for reptiles, amphibians.
- Permanent to seasonal water source for resident wildlife.
- Enhances adjacent habitat values.

Key Wildlife Aspects (Shoreline Zone):

- Shoreline of large ponds and reservoirs, characterized by presence of emergent vegetation and fluctuating water level.
- May provide habitat for bald eagle (FE, SE, CFP, BEPA); western grebe (SSA); northwestern pond turtle (FC2, CSC); California red-legged frog (FC1, CSC); foothill yellow-legged frog (FC2, CSC); Ricksecker's water scavenger beetle (FC2); great blue heron, great egret, snowy egret, black-crowned night heron (rookery in adjacent trees: SSA); California tiger salamander (FC2, CSC).
- Other attributes are the same as Pond or Reservoir - Open Water.

Associated Animal Species:

Largemouth bass	*Micropterus salmoides*
Rainbow trout	*Salmo gairdneri*
Prickly sculpin	*Cottus asper*
Bluegill	*Lepomis macrochirus*
Tule perch	*Hysterocarpus traski*
Sacramento sucker	*Catostomus occidentalis*
Threespine stickleback	*Gasterosteus aculeatus*
Rough-skinned newt	*Taricha granulosa*
California newt	*Taricha torosa*
Western toad	*Bufo boreas*
Pacific tree frog	*Hyla regilla*
Bullfrog	*Rana catesbeiana*
Pied-billed greeb	*Podilymbus podiceps*
Double-crested cormorant	*Phalacrocorax auritus*
Great blue heron	*Ardea herodias*
Great egret	*Casmerodius albus*
Snowy egret	*Egretta thula*
Green-backed heron	*Butorides striatus*
Green-winged teal	*Anas crecca*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Gadwall	*Anas strepera*
Common merganser	*Mergus merganser*
Ruddy duck	*Oxyura jamaicensis*
American coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Caspian tern	*Sterna caspia*
Belted kingfisher	*Ceryle alcyon*
Barn swallow	*Hirundo rustica*
Red-winged blackbird	*Ageaius phoeniceus*

Potential Special Status Animal Species:

Status	Occurrence	Species	
SE/FE/CFP/BEPA	R	Bald eagle	*Haliaeetus leucocephalus*
CSC/FC2	R	Northwestern pond turtle	*Clemmys marmorata*
FC1/CSC	P	California red-legged frog	*Rana aurora draytonii*
CSC/FC2	P	Foothill yellow-legged frog	*Rana boylii*
SSA	R	Western grebe	*Aechmophorus occidentalis*
*/SSA	R	Great blue heron	*Ardea herodias*
*/SSA	P	Great egret	*Casmerodius albus (rookery)*
*/SSA	P	Snowy egret	*Egretta thula*
*/SSA	P	Black-crowned night heron	*Nyctocorax nyctocorax*
FT	R	Aleutian Canada goose - (wintering)	*Branta canadinsis Teucopareia*
CSC	P	Osprey (nesting)	*Pandion haliaetus*
CSC/FC2	P	California tiger salamander	*Ambystoma californiense*
FC2	P	Ricksecker's water scavenger beetle	*Hydrochara rickseckeri*

Constraints/Sensitivities:

- These wetlands and waters of the U. S. are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.
- Resident species may be protected to varying degrees by state and federal statutes. Seasonal survey work for sensitive wildlife species should be done in all wetland areas to prevent inadvertent take.
- Vulnerable to filling, sedimentation, decreased water quality.
- Shoreline habitats are sensitive to human use-trampling, litter, disturbance of feeding, resting, and nesting habitat.
- Introduction of exotic aquatic wildlife (e.g., bullfrog) can be detrimental to native reptile and amphibian populations.
- May be adversely affected by reservoir drawdown, particularly in the spring - early summer nesting and breeding season.

Constraints/Sensitivities (Shoreline Zone):

- Same as Pond or Reservoir - Open Water.

COMMUNITY NAME:	**RIVERINE**
WILDLIFE HABITAT:	RIVERINE
COMMUNITY MAP NUMBER:	**17**

Structural Aspects:

Sedges root in gravel and algal cells cover boulders when light is adequate. Water moves down gradient forming pools and riffles if shallow enough, deep channels if a large river. Guide to Wildlife Habitats (Mayer and Laudenslayer [eds.]1988) describes Open Water as greater than two meters or seven feet and beyond the depth of rooted plants; Submerged zone as between Open Water and Shore; and Shore as seldom flooded except for waves and seasonal fluctuations, with under 10 percent vegetative cover.

Predominant Terrain Features:

Reservoirs may provide water source that keeps the river or stream flowing, sometimes during times of years when the river system would naturally be dry or at least much lower. If there is a steep gradient through hard rock, the stream channel becomes scoured and all soil suspended in water is deposited downstream or in the reservoirs. Where the gradient is less steep, the flow of the water slows and the suspended gravels, sands and silts accrete in bars and provide habitat for riparian vegetation. Changing water level means that the habitat is always changing. The amount of dissolved oxygen may vary to a small degree.

Predominant Climatic Conditions:

Little information is available in the literature about the climatic conditions of the Mount Hamilton Range. According to Sharsmith (1982) the average annual precipitation on Mount Hamilton is 32 inches and the average annual temperature is 53 degrees F. Summer fogs are frequent on the western slopes nd have a strong maritime influence, but the interior of the range is drier, having about 15 inches of rain per year and the eastern portion of the range only 9 inches annual precipitation. Water temperature is not constant because of changing flow and air temperatures throughout the year.

Elevation Range:

Permanent and intermittent streams flow in the Alameda watershed between approximately 2000 feet down to 500 feet elevation.

Characteristic Plant Species:

Algae	
Sedges	*Carex* spp.
White alder	*Alnus rhombifolia*

Special Status Plant Species:

None

Key Wildlife Aspects:

This habitat provides cover and foraging ground for invertebrates, amphibians and birds.

- Open, running water characterized by absence of emergent vegetation and a wide range of gradients, channel configurations, and flows.
- Reservoir operation may affect quantity and timing of streamflow to a great degree.
- May provide habitat for bald eagle (FE, SE, CFP); northwestern pond turtle (FC2, CSC); California red-legged frog (FC1, CSC); foothill yellow-legged frog (FC2, CSC); great blue heron, great egret, and snowy egret (rookery in adjacent trees: SSA); Ricksecker's water scavenger beetle (FC2).
- Open water is important link in Pacific Flyway; adjacent wetland habitats are heavily used by migratory passerines and other birds.
- Reproductive habitat for reptiles, amphibians.
- Permanent to seasonal water source for resident wildlife.
- Enhances adjacent habitat values.

Associated Animal Species:

Mayfly naiads, Blue-winged duns	*Ephemerella ssp.*
Pacific spotted mayfly	*Callibaetis pacificus*
Flat nymph mayflies	*Epeorus ssp.*
	Heptagenia ssp.
	Rhithrogena ssp.
Caddisfly larva	*(3 Families, 5 Genera)*
Alderfly larva	*Sialis californica*
Stonefly nymphs	*Calineuria, Capnia and Pteronarcys*
Rainbow trout	*Salmo gairdneri*
Prickly sculpin	*Cottus asper*
Bluegill	*Lepomis macrochirus*
California roach	*Hesperoleucus symmetricusi*
Rough-skinned newt	*Taricha granulosa*
California newt	*Taricha torosa*
Western toad	*Bufo boreas*
Great blue heron	*Ardea herodias*
Great egret	*Casmerodius albus*
Snowy egret	*Egretta thula*
Belted kingfisher	*Ceryle alcyon*
Barn swallow	*Hirundo rustica*
Red-winged blackbird	*Ageaius phoeniceus*
American dipper	*Cinclus mexicanus*

Special Status Animal Species:

Status	Occurrence	Species	
SE/FE/CFP/BEPA	R	Bald eagle	*Haliaeetus leucophalus*
FC2/CSC	R	Northwestern pond turtle	*Clemmys marmorata*
FC1/CSC	R	California red-legged frog	*Rana aurora draytonii*
CSC/FC2	R	Foothill yellow-legged frog	*Rana boyleii*
SSA	R	Great blue heron (rookery)	*Ardea herodias (rookery)*
SSA	R	Great egret (rookery)	*Casmerodius albus (rookery)*
SSA	R	Snowy egret (rookery)	*Egretta thula (rookery)*
FC2	P	Ricksecker's water scavenger beetle	*Hydrochara rickseckeri*

Constraints/Sensitivities:

- These wetlands and waters of the U. S. are protected by a variety of federal and state statutes administered by USFWS, USA COE, CDFG.
- Resident species may be protected to varying degrees by state and federal statutes.
- Seasonal survey work for sensitive wildlife species should be done in all wetland areas to prevent inadvertent take.
- Vulnerable to filling, sedimentation, decreased water quality.
- Shoreline habitats are sensitive to human use-trampling, litter, disturbance of feeding, resting, and nesting habitat.
- Introduction of exotic aquatic wildlife (e.g., bullfrog) can be detrimental to native reptile and amphibian populations.
- May be adversely affected by reservoir drawdown, particularly in the spring - early summer nesting and breeding season.

COMMUNITY NAME: **URBAN/BARE**
COMMUNITY MAP NUMBER: **18**

Structural Aspects:

Partial canopy cover similar to woodland, fruit for animal use as food, and structure for nesting and cover. Golf courses are open grasslands but very disturbed by human intrusion and chemical treatment.

Predominant Terrain Features:

Angular urban structures and streets.

Predominant Climatic Conditions:

Wet, cold winters and hot, dry summers.

Elevation Range:

Irrelevant.

Community Name Under Other Classification Systems:

Guide to Wildlife Habitat 1988	Urban (URB)
CalVEG 1981	Urban, Agriculture
Munz and Keck 1977	None
Cheatham and Haller 1975	None

Characteristic Plant Species:

Landscaping plants
Street trees
Rural vegetable gardens

Special Status Plant Species:

None

Key Wildlife Aspects:

- A variety of common, widely-adapted wildlife find adequate habitat in the urban forest.

Associated Animal Species:

Raccoon	*Procyon lotor*
Opossum	*Didelphis virginiana*
Striped skunk	*Mephitis mephitis*
House finch	*Carpodacus mexicanus*
Brown towhee	*Papilo fuscus*
House sparrow	*Passer domesticus*
Starling	*Sturnus vulgaris*
House mouse	*Mus musculus*
Botta pocket gopher	*Thomomys bottae*

Special Status Animal Species:

None

Constraints/Sensitivities:

- High degree of disturbance and human presence.

3.0 WILDLIFE

REGIONAL OVERVIEW

The Alameda Watershed is within the Mt. Diablo Range, which separates the Bay Area coastal habitats from the interior San Joaquin Valley habitats. Ridgelines and open water within this area are important features of the Pacific Flyway. This watershed provides winter foraging and resting habitat for migrating and resident bird species, attracting raptors (birds of prey), waterfowl, and passerines (perching birds). Wildlife habitats include non-native grasslands on south-facing slopes; coast live oak woodland in ravines feeding into the reservoir; blue oak woodlands on north facing slopes; and coastal scrub on south facing slopes. Willow riparian, coast live oak riparian, and white alder riparian occur along the major creeks and tributaries to the reservoir. The watershed lands act as a buffer between the surrounding urban areas and the many square miles of open space and wildlife habitat to the east.

San Antonio Reservoir, located north of Calaveras Reservoir, has a northeast-southwest orientation, with a majority of its tributary streams in the eastern portion of the watershed. Most of these streams flow northwest down narrow ravines into La Costa Valley. Calaveras Reservoir has a north-south orientation with streams flowing north to the reservoir and to Alameda Creek beyond.

RESOURCE DESCRIPTION

Wildlife habitat mapping unit boundaries shown in Figure 3-1 correspond directly to the natural community delineations discussed in Section 2.0. Table 3-1 cross-references the various natural community classifications to the units used in the wildlife habitat mapping. In a few places, structurally similar vegetational habitats have been combined into one wildlife habitat type, and some of the relatively widespread vegetation types have been further subdivided with overlay zones. These adjustments were made where the wildlife habitat attributes were not completely contained within the vegetational community. Vegetation communities are defined by the plant species and successional stage, while wildlife habitats, although based on vegetational communities, are modified by other physical characteristics of the environment. Animals are mobile, and may move from one vegetational type to another for life cycle needs.

TABLE 3-1: ALAMEDA WATERSHED WILDLIFE HABITATS

WILDLIFE HABITAT	NATURAL COMMUNITY
Mixed Evergreen Forest/ Coastal Oak Woodland	Mixed Evergreen Forest/ Coast Live Oak Woodland
Valley Oak Woodland	Valley Oak Woodland
Blue Oak Woodland	Blue Oak Woodland
Willow Riparian Forest	Central Coast Arroyo Willow Riparian Forest
Coast Live Oak Riparian	Central Coast Live Oak Riparian Forest
White Alder Riparian Forest	White Alder Riparian Forest
Sycamore Alluvial Woodland	Sycamore Alluvial Woodland
Coastal Scrub	Northern Coastal Scrub Mixed Chaparral Chamise Chaparral
Annual Grassland	Non-native Grassland
Fresh Emergent Wetland	Coastal and Valley Freshwater Marsh
Riverine	
Lacustrine	Pond or Reservoir
Pasture	Cultivated

SOURCE: Environmental Science Associates, 1993.

The wildlife habitat categories used in this study are based on the classification system developed by Mayer and Laudenslayer (1988) in the Wildlife Habitat Relationship System (WHR). Because some of the WHR categories are relatively broad and inclusive, a number of these habitat categories have been subdivided into more specific habitat types, such as Willow Riparian Forest, Coast Live Oak Riparian Forest, White Alder Riparian Forest, and Sycamore Alluvial Woodland, as described by Holland (1986). WHR mapping units were chosen as a reference because the system is widely used and can act as a predictive tool to assess and compare long-term consequences of management options.

Aspects of the watershed wildlife habitats are discussed below. The Natural Community Tables found at the end of Section 2.0 provide a description of the natural communities and their structural, climatic, and geographic features, as well as their associated plants and common wildlife species. Special status species that have been reported or that may potentially occur, and other sensitivities within the habitat are also described. Figure 3-2, Known Special Status Wildlife Species Occurrence on the Alameda Watershed, indicates the areas where some special status species are known to occur. Additionally, individual Special Status Wildlife Species Descriptions are given at the end of this section.

Wildlife Habitats

Mixed Evergreen Forest/Coastal Oak Woodland

This habitat is a fairly dense woodland which grows predominantly on the northeast-facing slopes of the Alameda reservoirs. Structurally, this habitat is composed of a hardwood tree layer, ranging in height from 60-90 feet, with a patchy shrub stratum and sparse herbaceous layer. Snags and downed woody material are generally sparse throughout.

Mixed evergreen forests contains food for species such as chestnut-backed chickadee, Steller's jay, pygmy nuthatch, and warbling vireo. These species are bark gleaners: they eat insects that are in the bark of trees, as well as catching insects in flight. The rufous-sided towhee, and brown towhee glean insects from the foliage on the ground, such as under leaf litter and plants. Rufous hummingbirds use vines growing around trees for nectar and for insects that are attracted to the nectar. Other species, such as the great horned owl, use the tall trees as roosting and foraging sights during the day. The western gray squirrel and gray fox both feed on truffles, mushrooms, fruits, and nuts within the forest.

Sensitivities and constraints for this habitat are the potential for a high intensity fire due to the excessive undergrowth and/or downed branches. High fire temperatures could cause significant damage to trees, wildlife, propagules, and seeds that would survive a less catastrophic burn. Special status species potentially occurring in this habitat are nesting black-shouldered kite, sharp-shinned hawk, Cooper's hawk, pallid bat, and ringtail.

Valley Oak Woodland

This woodland is an open savannah with a canopy of 30 to 40 percent and an understory of grasslands. In the watershed lands this habitat occurs on the south-facing slopes in drainages and interdigitates with a variety of other habitats.

This woodland is similar in wildlife species composition to other woodland habitats. Predators such as red-shouldered hawk, red-tailed hawk and Cooper's hawk feed on small mammals in adjacent grasslands. Cavity nesting species, such as European starlings, use holes in tree trunks, and acorn eaters such as scrub jay, acorn woodpecker can be seen amongst the branches. Bark gleaners, such as plain titmouse, Bewick's wren, bushtit, are also seen in the branches catching insects. Understory ground dwellers, such as California quail, rufous-sided towhee, are ground foliage gleaners. Mammals include several tree squirrels, such as fox and gray squirrels, nesting and foraging in this habitat. Mule deer feed on young oak shoots and acorns during the winter.

Sensitivities and constraints for this habitat and wildlife use include limited reproduction of valley oak from a variety of causes (e.g. cattle, drought, fungus, etc.), and disturbance of nesting bird species during the spring. If trees are to be removed or cleared of dead wood, it should not be conducted during the spring. Special status species potentially occurring in this habitat are nesting black-shouldered kite, sharp-shinned hawk, Cooper's hawk; pallid bat ; and ringtail.

California tiger salamanders could occur in this habitat type wherever there is seasonal ponding from winter rains.

Blue Oak Woodland

This habitat consists of an overstory of scattered trees, with the density of trees determined by water availability. This community grows on northeast-facing, slopes that are dry or well drained, and interdigitates with a variety of other habitats.

This habitat offers the same foraging and nesting resources as do other oak woodlands.

Sensitivities and constraints for this habitat are the potential for a high intensity fire due to the excessive undergrowth and/or downed branches. High temperatures could cause significant damage to trees, wildlife, propagules, and seeds that would survive a less catastrophic burn. Limited reproduction of blue oak from a variety of causes (e.g. cattle, drought, fungus), and disturbance of nesting bird species during the spring are other constraints to this habitat. If trees are to be removed or cleared of dead wood, it should not be conducted during the spring. Special status species potentially occurring in this habitat include nesting black shouldered kite, sharp-shinned hawk, Cooper's hawk, pallid bat, and ringtail.

Willow Riparian

This habitat is a low shrubby tree structure that can cover an entire watercourse, with an impenetrable understory and includes fallen limbs and other debris. In the Alameda Watershed this habitat occurs along the eastern edges of the San Antonio Reservoir and elsewhere along shorelines and streams.

Willow riparian is a moist-to-wet habitat type, with high primary productivity. Decay organisms and larvae in the damp litter feed insects and other small animals, which in turn support a complex food web. This habitat is important breeding habitat for amphibians. The physical structure of the trees provides a protected travel corridor between aquatic and upland habitat types, and is an important feeding and resting place for resident and migratory birds.

Warblers and the black phoebe are common insect-eating birds that use the willows. Mallards and snowy egrets use the shallow quiet waters of the river or stream to forage for vegetation and small fish. The American crow is found in this habitat and others, feeding on insects, fruits, carrion, amphibians, and reptiles. Predators, such as sharp-shinned hawks and red-shouldered hawks, nest in the high canopy and feed on the smaller birds and amphibians. Omnivores, such as the raccoon and striped skunk forage on invertebrate species, plant parts, amphibians and fruits. The striped skunk is found in most habitats within the watershed lands.

Sensitivities and constraints for this habitat are wetlands, which are protected by a variety of federal and state statutes administered by USFWS, COE, and CDFG, and are vulnerable to filling, sedimentation, and decreased water quality. Shorelines provide habitat for feeding and nesting for various special status species, and are sensitive to human disturbance. This habitat is

also vulnerable to introductions of exotic animals, such as bullfrog, which compete/predate on native amphibians and reptiles, and introductions of invasive exotic plants. Mitigation for impacts to this habitat is difficult since creation of new wetlands is rarely successful. This habitat may be adversely affected by reservoir drawdown, decreasing habitat for special status species.

Special status species potentially found in this habitat are Ricksecker's water scavenger beetle, California red-legged frog, northwestern pond turtle, saltmarsh common yellowthroat, nesting black-shouldered kite, nesting sharp-shinned hawk, and nesting Cooper's hawk. Please refer to the Special Status Wildlife Species Descriptions at the end of this section for more information on each species.

Coast Live Oak Riparian

This habitat is an open, low, evergreen forest, similar in most respects to the adjacent upland woodland. Found in canyon bottoms and the drier outer floodplains, the understory for this habitat is poison oak, blackberry bushes, and snowberry in the wetter areas and poison oak and grasses in the drier areas.

As with other riparian habitats, coast live oak riparian provides water, foraging, nesting, cover, and migrating and dispersal corridors for a variety of wildlife species. The primary distinguishing attribute of this habitat type is its topographic configuration along incised drainages, and the presence of seasonal water which increases biological productivity. In general, coast live oak riparian is continuous with the adjacent upland vegetation, and so does not form the same distinctive linear corridor that a willow or sycamore woodland does.

Common insect eaters and foliage gleaners include ash-throated flycatcher, plain titmouse, and dark-eyed junco. Bark gleaner species, such as scrub jay, Steller's jay, and acorn woodpecker, feed on insects as well as acorns. California quail and brown towhee are the ground foliage gleaners in this habitat. Red-shouldered hawks can be seen foraging on small mammals in the adjacent grassland from the protection of the coast live oak riparian forest. Cooper's hawks and sharp-shinned hawks are often associated with this habitat hunting small birds. Mammals such as grey squirrel forage and nest in the canopy of the trees while long-tailed weasels hunt for shrews and meadow voles on the ground. Larger mammals, such as mule deer use the wet understory of this community, i.e. poison oak, and blackberry bushes, in the form of shelter and

food from the berries. Amphibians like the Pacific slender salamander, rough skinned newt, and ensatina can be found underneath the cover of fallen leaf litter and bark.

Sensitivities and constraints for this habitat are potential wetlands, which are protected by a variety of federal and state statutes administered by USFWS, COE, and CDFG, and are vulnerable to filling, sedimentation, and decreased water quality. Shorelines, providing habitat for feeding and nesting, are sensitive to human disturbance. Shorelines are susceptible to introduction of exotic animals, such as bullfrog, which compete/predate on native amphibians and reptiles. Mitigation for this habitat is difficult as creation of new wetlands are rarely successful. Special status species potentially occurring in this habitat are nesting black-shouldered kite, sharp-shinned hawk, and Cooper's hawk; pallid bat; and ringtail .

White Alder Riparian Forest

This habitat occurs along the Arroyo Hondo and Alameda Creek, interspersed with Sycamore Alluvial Woodland. White alder riparian forest is a tall, shrubby, winter deciduous forest that forms a dense-to-open canopy. Often located at the bottom of a canyon stream course, this habitat consists of a narrow grove of trees with a sparse understory.

This habitat offers the same aspects for wildlife as willow riparian, due to the dense structure of the canopy for cover, moist environment for insects and foraging, and the location along streams.

Sensitivities and constraints for this habitat are potential wetlands, which are protected by a variety of federal and state statutes administered by USFWS, COE, and CDFG, and are vulnerable to filling, sedimentation, and decreased water quality. Shorelines, providing habitat for feeding and nesting, are sensitive to human disturbance. Shorelines are susceptible to introduction of exotic animals, such as bullfrog, which compete/predate on native amphibians and reptiles. Mitigation for this habitat is difficult as creation of new wetlands are rarely successful.

Special status species potentially occurring in this habitat are nesting sharp-shinned hawk and Cooper's hawk, ringtail, California red-legged frog, foothill yellow-legged frog, and northwestern pond turtle.

Sycamore Alluvial Woodland

This habitat consists of large deciduous trees that occur in the bottoms of ravines and canyons. It is often interspersed with cottonwood and oaks, as found along the east end of San Antonio Reservoir, the south end of Calaveras Reservoir and along Alameda Creek.

Because this habitat occurs in streams that are ephemeral or have no visible stream flow, wildlife species move in and out of this habitat throughout the year. Amphibians, such as California red-legged and foothill yellow-legged frog, move upstream when the water recedes and reptiles, such as the Alameda whipsnake, come from adjacent coastal scrub habitat and use the sycamore alluvial woodland as extended habitat for foraging and drinking. The large trees and thin canopy allow for perching surfaces for foraging raptors, such as red-tailed hawks and black-shouldered kites. Mammals such as striped skunk and raccoon forage underneath rocks in the creek bottom for insects and amphibians, such as western toad and coast range newt. Birds and mammals use the woodland as a movement corridor.

Sensitivities and constraints for this habitat are potential wetlands, which are protected by a variety of federal and state statutes administered by USFWS, COE, and CDFG, and are vulnerable to filling, sedimentation, and decreased water quality. Shorelines, providing habitat for feeding and nesting, are sensitive to human disturbance. Shorelines are susceptible to introduction of exotic animals, such as bullfrog, which compete/predate on native amphibians and reptiles. Mitigation for this habitat is difficult as creation of new wetlands are rarely successful.

Special status species potentially occurring in this habitat include Alameda whipsnake, northwestern pond turtle, California red-legged frog, foothill yellow-legged frog, nesting black-shouldered kite, Cooper's, and sharp-shinned hawk.

Coastal Scrub

This habitat is open and low in profile, with extensive shrubby vegetation usually seen on the west-and east-facing slopes within the watershed. This habitat often occurs on shallow, rocky soils, in areas with an average rainfall of 12 inches.

Coastal scrub habitat contains species that are attracted to edges of communities, such as grasslands or oak woodland or chaparral, for foraging and nesting. Coastal scrub is less

vegetatively productive than adjacent chaparral habitats, but seems to support equivalent numbers of wildlife species (Mayer and Laudenslayer 1988).

Sensitivities and constraints for this habitat are the potential for a high intensity fire due to the excessive undergrowth and/or downed branches. A high temperature fire could cause significant damage to trees, wildlife, propagules, and seeds that would survive a less catastrophic burn. Alameda whipsnake require connections between core habitat areas in coastal scrub areas, and outlying foraging and home range patrol areas. Other special status species that could occur in this habitat are loggerhead shrike, California horned lizard, western whiptail, and nesting sharp-shinned hawk.

Mixed Chaparral Habitat

Mixed chaparral often contains dense, impenetrable overstory of pure stands of a single species or a diverse mixture of several species, with abundant leaf litter which precludes growth of any understory. Within the Alameda Watershed the steeply sloping sides and ridges with rocky soils containing coastal scrub could support mixed chaparral.

Chaparral habitat contains foraging and nesting habitat for species that are attracted to edges of the adjacent grassland or oak forest communities. These species include mountain quail, California quail, California thrasher, mourning dove, and rufous-sided towhee. Avian species that use the canopy of the chaparral for catching insects include phainopepla, ash-throated flycatcher, and wrentit. Flowers of the manzanita and ceanothus attract nectar drinkers such as Anna's hummingbird. If cliffs and water are nearby, prairie falcons and sharp-shinned hawks will use chaparral for foraging grounds. Mammals use this habitat for protection and foraging grounds, feeding off new shoots of plants. These species include brush rabbits, gophers, and deer mice. Small mammals attract predators such as long-tailed weasel, grey fox, red fox, and bobcat. Western rattlesnakes and western fence lizards inhabit the warm, dry chaparral community.

Sensitivities and constraints for this habitat are the potential for a high intensity fire due to the excessive undergrowth and/or downed branches. A high temperature fire could cause significant damage to trees, wildlife, propagules, and seeds that would survive a less catastrophic burn. Nesting avian species are most vulnerable during the spring nesting season. Special status species that could occur in this habitat are loggerhead shrike, coast horned lizard, and western whiptail.

Chamise chaparral

Chamise chaparral, dominated by chamise, does not contain the diversity of wildlife food as does coastal scrub, due to the monotypic species in this habitat. This dense vegetation often forms closed canopies in older stands (25 years), thus prohibiting the growth of understory herbaceous plants. Senescence is reached in 25 to 60 years, in the absence of fire. Most chamise stands are outside the SFWD watershed lands.

Wildlife species use chamise chaparral for cover and movement. The canopy is too low (three to six feet) and dense for nesting raptors. Predators, such as grey fox or bobcat, prey on small mammals along the edges of the habitat. This habitat provides cover and foraging opportunities for reptiles.

Sensitivities and constraints for this habitat are the potential for a high intensity fire due to the excessive undergrowth and/or downed branches. A high temperature fire could cause significant damage to trees, wildlife, propagules, and seeds that would survive a less catastrophic burn. Special status species potentially occurring in this habitat are loggerhead shrike and coast horned lizard.

Annual Grassland

Grassland is important habitat for wildlife that requires unobstructed line-of-sight for hunting, communication, and territorial defense. Annual grassland has replaced native grassland throughout California, and although the functions are similar, native perennial grassland has greater species diversity, better soil and moisture retention capabilities, superior forage quality, and a higher overall habitat value. Annual grassland on the Alameda watershed is extensively influenced by cattle grazing.

Grassland habitat attracts seed eaters as well as insect eaters. California quail, mourning dove, and meadowlarks are a few seed eaters that use grasslands for nesting. Insect eaters such as scrub jays, barn swallows, and mockingbirds use the habitat for foraging only. Mammals such as California vole, deer mouse, broad-footed mole, and black-tailed jackrabbit forage and nest within the grassland. Mule deer will use grassland for grazing and for nesting at night. Small rodents attract raptors (birds of prey) such as red-tailed hawks, and red-shouldered hawks. Southern alligator lizard and Pacific slender salamander use the grassland for invertebrates found within and underneath fallen logs.

Small, summer-dry seasonal ponds in the grasslands are important habitat for the California tiger salamander. Because of their ephemeral nature, not all of these ponds have been mapped.

Sensitivities and constraints for this habitat are overgrazing and susceptibility of invasion by non-native plant species, grazing, fence building, grading, clearing, and burning near sensitive species. Surveys for all sensitive species should be conducted prior to any project in this habitat. Extensive poisoning of ground squirrels may have direct and indirect impacts on several listed species. Special status species potentially occurring in this habitat are callippe silverspot butterfly, western spadefoot toad (seasonal rainponds), California tiger salamander (seasonal rainponds), loggerhead shrike, black-shouldered kite, ferruginous hawk (wintering), prairie falcon, American badger, California horned lark, golden eagle, and burrowing owl.

The San Antonio Grassland zone around San Antonio Reservoir and some cultivated hay fields near Pleasanton are delineated as a distinct wildlife habitat unit. These grasslands contain unique wildlife values, including potential San Joaquin kit fox habitat, burrowing owl habitat, and known nesting golden eagles. Special status species potentially occurring in this habitat are the same species listed above, with the addition of San Joaquin kit fox and short-eared owl.

Serpentine Barrens

This habitat is underlain by serpentine soils, and is characterized by specially adapted plant species. In the Alameda Watershed, the predominant vegetation type underlain by serpentine appears to be perennial grassland (see below). Structurally this habitat is very open with sparse ground cover and a height of one to two feet. "Barrens" is a misleading term referring to the spare stature of the vegetation, and not to the biotic value of this habitat type. Serpentine barrens delineated on Figure 3-1 are based on the occurrence of serpentine soils and bedrock outcrops.

Sensitivities and constraints for this habitat are overgrazing and susceptibility of invasion by non-native plant species, grazing, fence building, grading, clearing, and burning near sensitive species. Surveys for all sensitive species should be conducted prior to any project in this habitat. Special status species potentially occurring in this habitat include bay checkerspot butterfly, serpentine phalangid, Opler's longhorn moth, western spadefoot toad (seasonal rainpools), California tiger salamander (seasonal rainpools), golden eagle, nesting black-shouldered kite, wintering ferruginous hawk, nesting prairie falcon, burrowing owl, loggerhead shrike, California horned lark, and American badger.

Perennial Grassland

Introduced annual grassland, which is adapted to cattle grazing, has replaced native grassland throughout most of California. Remnants do remain, however, and there are small, unmapped patches of native perennial grasses interspersed with annual grassland throughout the Alameda Watershed. Grassland with greater than 10% cover by perennials can be considered perennial grassland (Holland, pers. comm.). Native perennial grassland has greater structural diversity, higher forage values, and better soil and moisture retention than introduced annual grassland.

Sensitivities and constraints for this habitat are overgrazing and susceptibility of invasion by non-native plant species, fence building, grading, clearing, and burning near sensitive species. Surveys for all sensitive species should be conducted prior to any project in this habitat.

Small, summer-dry seasonal ponds in the grasslands may be important habitat for the California tiger salamander. Because of their ephemeral nature, not all of these ponds have been mapped.

Other special status species potentially occurring in this habitat include callippe silverspot butterfly, western spadefoot toad (seasonal rainpools), California tiger salamander (seasonal rainpools), golden eagle, black-shouldered kite, ferruginous hawk, prairie falcon, burrowing owl, loggerhead shrike, California horned lark, and American badger.

Fresh Emergent Wetland

This transitional habitat occurs between terrestrial and aquatic systems where water tables are near the surface or land is covered by shallow water. Fresh emergent wetlands can form around the margins of the reservoirs, especially where a watercourse enters. For example, fresh emergent wetland is found around the eastern edge of San Antonio Reservoir, in isolated permanent ponds, and even in seasonal ponds. Tules, cattails, and other grass-like emergent plants typically form a dense canopy.

This habitat is one of the most productive habitats for wildlife because it offers water, food, and cover for a variety of species. Northern harrier, black necked stilts, avocets, red-winged blackbirds, and killdeer use these areas for foraging and nesting. Snowy egret, black crowned night heron, and cinnamon teal also forage in this habitat. Mammals common in this habitat are meadow voles along the edges of the marsh area, raccoons foraging on eggs and invertebrates,

striped skunk, and grey fox. Reptiles in this habitat include common garter snake and tree frogs and possibly red-legged frogs

Wetlands are typically protected by a variety of federal and state statutes administered by USFWS, COE, and CDFG, and are vulnerable to filling, sedimentation, and decreased water quality. Shorelines, providing habitat for feeding and nesting, are sensitive to human disturbance. Shorelines are susceptible to introduction of exotic animals, such as bullfrog, which compete/predate on native amphibians and reptiles. Mitigation for this habitat is difficult as creation of new wetlands are rarely successful.

Special status species reported from or potentially occurring in this habitat are tricolored blackbird, western grebe, great blue heron (rookery), California red-legged frog, northwestern pond turtle, and Ricksecker's water scavenger beetle.

Riverine

Streams, rivers, and their banks make up this habitat. Streams in the Alameda Watershed flow from their source in a rocky bed along a steep a gradient at relatively high velocity. At lower elevations the velocity decreases, the water becomes sluggish, and sedimentation causes the bottom to become muddy so that temperature and turbidity increase.

This habitat supports a variety of species that use the stream course and the banks, such as American dipper, kingfisher, red-legged and yellow-legged frogs; the understory is foraged by ringtails, mule deer, raccoon, California quail, brown towhee, and garter snakes; and the overstory is used for nesting and roosting by Bewick's wren and others. Open water is an important link in the Pacific Flyway which runs along the Coastal mountain ranges, as well as providing breeding habitat for reptiles and amphibians, and a permanent water source for resident wildlife.

Sensitivities and constraints for this habitat are potential wetlands, which are protected by a variety of federal and state statutes administered by USFWS, COE, and CDFG, and are vulnerable to filling, sedimentation, and decreased water quality. Shorelines, providing habitat for feeding and nesting, are sensitive to human disturbance. Shorelines are susceptible to introduction of exotic animals, such as bullfrog, which compete/predate on native amphibians and reptiles. Mitigation for this habitat is difficult as creation of new wetlands are rarely successful. Special status species known to use or potentially occurring in this habitat include

bald eagle, northwestern pond turtle, California red-legged frog, foothill yellow-legged frog, great blue heron, great egret, snowy egret, and Ricksecker's water scavenger beetle. A small rookery used by great blue herons is situated along the bank of a small stream tributary to San Antonio Reservoir.

Pond or Reservoir

This habitat contains standing water, from either a dammed river channel or an inland depression. Sizes may vary from pond size, less than one hectare, to reservoir size of several square miles. Most permanent lacustrine systems support fish, while intermittent forms do not (see Section 4.0). This habitat type has been subdivided into two functionally distinct zones, open water and shoreline.

Reservoirs are very important as watering holes for wildlife. Riparian areas leading into the reservoir and fresh emergent wetland habitat around the edges are used by nesting birds. Shallow ponds are often free of predatory fish and provide warmer waters during the spring and summer season for invertebrate, amphibian, and reptile species.

Wetlands are typically protected by a variety of federal and state statutes administered by USFWS, COE, and CDFG, and are vulnerable to filling, sedimentation, and decreased water quality. Shorelines, providing habitat for feeding and nesting, are sensitive to human disturbance. Shorelines are susceptible to introduction of exotic animals, such as bullfrog, which compete/predate on native amphibians and reptiles. Mitigation for this habitat is difficult as creation of new wetlands are rarely successful.

Special status species potentially occurring on open water and shorelines in the ponds and reservoirs are California red-legged frog, foothill yellow-legged frog, California tiger salamander, northwestern pond turtle, Ricksecker's water scavenger beetle, wintering Aleutian Canada goose (open water zone), nesting western grebe, black-crowned night heron, great blue heron, great egret, snowy egret, bald eagle, and osprey(open water zone).

Disturbed Lands

Agricultural lands are characterized by constant or periodic disturbance and generally do not provide the same habitat values for mammals, reptiles, and amphibians as they do for birds. The requirements of many animals for food and cover from predators and the elements in their

territory, as well as those for suitable courting and pairing habitats are generally not met by agricultural uses. Wildlife using disturbed lands are typically common urban species like feral cat, raccoon, striped skunk, and opossum.

Grazed pasture lands are used by broadly-adapted grassland wildlife species found historically in grasslands of the region. California ground squirrels, attracted to the short grasses for safety reasons, create burrows that are important habitat for various species, such as burrowing owls and tiger salamanders. Resident birds of prey, such as red-tailed hawk and black-shouldered kite, use these areas for hunting small mammals. Other raptors, such as merlin and Swainson's hawk, use these types of fields for hunting during the winter migration along the Pacific Flyway. Avian species typically found in these agricultural areas include pheasant, dove, red-tailed hawk, northern flicker, crow, and western meadowlark. Wildlife species typically include red fox, skunk, raccoon, opossum, jackrabbit, cottontail, California ground squirrel, California vole, western harvest mouse, western fence lizard, and gopher snake.

Heavily-used residential parks and disturbed areas provide little habitat for wildlife except for those species adapted to human habitation, such as starlings, golden-crowned sparrows, and rock doves. These areas do not provide good habitat for the larger mammalian species nor for predators, except as possible movement corridors.

SENSITIVE RESOURCES

Background research for this report determined that there is good potential habitat within the watershed lands for a number of special status or legally protected animal species that are known to occur nearby. However, because public access to the SFWD lands has long been limited, the existing data on rare animals within the watershed itself must be regarded as incomplete. While there have been a few surveys done by specialists for specific taxa (e.g., nesting raptors around San Antonio Reservoir and wild pig studies around Calaveras Reservoir), these surveys have been limited in scope and do not give comprehensive information on the watershed-wide status and distribution of these animals. Because SFWD has certain legal obligations to protect listed species, this report has attempted to identify areas and habitat types where there is a high probability of finding these species. Documented occurrences of special status species on similar habitat in the vicinity of the watershed has been interpreted to mean that there is a very high probability that those species are likely to occur on the watershed.

Table 3-2 lists those special status animal that can potentially occur on the watershed and the ideal survey period for each. Table 3-3 lists reported and potentially occurring species by habitat These tables are intended for use in identifying possibly sensitive areas where additional information is needed. At the end of this section are Special Status Wildlife Species Descriptions that provide a brief introduction to the habitat, range and life cycle of each species.

Figure 3-2 indicates the areas in which special status species habitat is known to occur. Data for Tables 3-2, 3-3 and Figure 3-2 are based on interviews with resource specialists, published literature, field inspection, CNDDB records and from well-documented anecdotal sightings and unpublished reports obtained during the background research for this project. Because of the gaps inherent in these data, absence of documented occurrence in Tables 3-2 and 3-3 or Figure 3-2 cannot be interpreted as absence of these species from the watershed lands.

REGULATORY FRAMEWORK

Special status species include those listed or proposed for listing by federal or state governments as endangered, threatened, or fully-protected, as well as candidates for such listing. These species have varying degrees of legal protection under both federal and California Endangered Species Acts (FESA and CESA), the California Fish and Game Code, and recognition under the California Environmental Quality Act (CEQA). The United States Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) are both responsible for protection of listed species. The California Environmental Quality Act (CEQA) requires disclosure of sensitive species that might be affected by certain proposed projects, but in and of itself CEQA does not provide legal protection for those species.

Informal consultation with USFWS and CDFG is recommended for any project or activity that might affect a state or federal listed species. A permit is required for any activity that would result in "take:" killing, harming, harassing, or otherwise disturbing listed species. In some cases, destruction of habitat may be considered take. The USFWS recommends candidate species also be considered because they may become listed during the design or construction phases of a project.

In addition to the formal species listing designations given in Table 3-4, the CDFG has developed a list of "Species of Special Concern" and "Special Animals." These species are defined as having California breeding populations which are of special concern in that they may face extinction within the State in the near future, or with fluctuating populations that should be

SPECIAL STATUS WILDLIFE SPECIES DESCRIPTIONS

TABLE 3-2: ALAMEDA WATERSHED SPECIAL STATUS WILDLIFE SPECIES AND SURVEYING TIMES

Scientific Name	Status	Habitat Occurence	Survey Time
Insects			
Adella oplerella Opler's longhorn moth	FC2	serpentine grassland	
Calcina serpentinea Serpentine phalangid	SSA	serpentine outcrops	
Euphydryas editha bayensis Bay checkerspot butterfly	FT	serpentine outcrops	
Hydrochara ricksecker Ricksecker's water scavenger beetle	FC2	freshwater ponds, shallow water of streams marshes and lakes	Jan-July
Speyeria adiaste adiaste Unsilvered fritillary	FC2	grasslands with Viola pedunculata	
Speyeria callippe callippe Callippe silverspot	FC1	grasslands with Viola pedunculata	
Amphibian			
Rana aurora draytonii California red-legged frog	CSC/FC1	ponds with emergent vegetation	Oct.-Nov. April-June
Rana boylei Foothill yellow-legged frog	CSC/FC2	streams with some summer flow and quiet pools	Oct.-Nov. April-June
Ambystoma californiense California tiger salamander	CSC/ FC2	seasonal and freshwater ponds	Oct.-Nov. April-May
Scaphiopus hammondii Western spadefoot toad	FC2	alkali sinks and grassland pools	Mid- Feb-Aug
Reptile			
Clemmys marmorata marmorata	CSC/FC2	freshwater ponds and slow streams with no predatory fish	all year
Masticophis lateralis euryxanthus Alameda whipsnake	ST/FC2	south facing slopesof coastal chaparral with drainages	all year
Phrynosoma coronatum frontale California horned lizard	CSC	sand and loose soil in scrub	all year
Cnemidophorus tigris multiscutatus Coastal western whiptail	FC2	dry open habitats	all year

TABLE 3-2: ALAMEDA WATERSHED SPECIAL STATUS WILDLIFE SPECIES AND SURVEYING TIMES

Scientific Name	Status	Habitat Occurence	Survey Time
Birds			
Accipiter cooperii Cooper's hawk	CSC	nests in riparian growths of deciduous trees and live oaks	May- July
Accipiter striatus Sharp-shinned hawk	CSC	nests in riparian growths of deciduous trees and live oaks	April-July
Aechmophorus occidentalis Western grebe	SSA	quiet lakes with tules or rushes	March-May
Agelaius phoeniceus	CSC/FC2	ponds, drainages slow moving streams with abundant tules	May-July
Aquila chrysaetos Golden eagle	CSC/CFP/BEPA	nests in oak savannah here open habitats especially over grassland	Dec.-July
Ardea herodias (rookery) Great blue heron	SSA	trees along lakes and estuaries	all year
Asio flammeus (nesting) Short-eared owl	CSC	nests in open grasslands	March-June
Branta canadensis leucopareia Aleutian Canada goose	FT	winters on lakes and inland prairie	Winter
Buteo regalis (wintering) Ferruginous hawk	CSC/ FC2	winters in flat open grasslands	Winter
Elanus caeruleus Black-shouldered kite	CFP	nests in trees adjacent to wet meadows and open grasslands	March-June
Eremophila alpestris actia California horned lark	FC2/CSC	open grasslands and irrigated pastures	all year
Falco mexicanus (nesting) Prairie Falcon	CSC	nests on cliffs, foraging from dry open terrain to marshes	all year
Haliaeetus leucocephalus	FE/SE/CFP/BEPA	nests and forages on inland lakes, reservoirs, rivers	Winter
Lanius ludovicianus Loggerhead shrike	FC2/CSC	open grasslands and shrublands	Winter
Pandion halieetus (nesting)	CSC	fresh water lakes, and large streams near forest	March-June

TABLE 3-2: ALAMEDA WATERSHED SPECIAL STATUS WILDLIFE SPECIES AND SURVEYING TIMES

Scientific Name	Status	Habitat Occurence	Survey Time
Birds			
Pelecanus erythrorhynchos (nesting colony) American white pelican	CSC	winters, but does not nest anywhere in the watershed and not expected to in this area	May-July
Speotyto (=Athene) cunicularia (burrow sites) Burrowing owl	CSC	nests in mammal burrows in open, sloping grasslands	Feb.-June
Mammals			
Antrozous pallidus Pallid bat	CSC	open lowland areas	Nocturnal
Plecotus townsendii townsendii Townsend's western big-eared bat	FC2/CSC	special roost requirements	Nocturnal
Eumops perotis Western mastiff bat	FC2/CSC	special roost requirements	Nocturnal
Dipodomys hermanni berkleyensis Berkeley kangaroo rat	SSA	historic record exists	Nocturnal
Bassariscus astutus Ringtail	CFP	brushy and woody courses along waterways	Nocturnal
Cervus elaphus Tule elk		Open grasslands to oak woodland and coniferous forests	All year
Taxidea taxus American Badger	CSC	Open grasslands with sandy soils	all year

STATUS CODES
Federal:
FE=Listed as Endangered on the Federal Endangered Species List
FT=Listed as Threatened on the Federal Endangered Species List
FC1=Category 1 Candidate for Federal listing (taxa for which the U.S. Fish and Wildlife Service has sufficient biological information to support a proposal to list as Endangered or Threatened)
FC2=Category 2 Candidate for Federal Listing (taxa for which existing information may warrant, but for which substantial bilogical information to support a propsed rule is lacking).

State Listed Species:
CE= Listed as Endangered, California Endangered Species Act
CT=Listed as Threatened, California Endangered Species Act
CSC=California Species of Special Concern
SSA=State designated special animal, designated by CDFG biologists
CFP = California Fully Protected, pursuant to CDFG Sections 3511, 4700, 5050, 5515.

SOURCE: CDFG/CNDDB, 1992; U.S.F.W.S. 1993; Grinnell and Miller, 1944; Environmental Science Associates, Inc., 1992.

TABLE 3-3: POTENTIALLY OCCURRING SPECIAL STATUS WILDLIFE SPECIES BY HABITAT ON THE ALAMEDA WATERSHED

VEGETATION COMMUNITY NAME (WILDLIFE HABITAT NAME)

Mixed evergreen forest/coastal live oak woodland (Mixed evergreen forest/coastal oak woodland)

Black-shouldered kite	Pallid bat
Cooper's hawk	Ringtail
Sharp-shinned hawk	

Valley oak woodland (Valley oak woodland)

California tiger salamander	Sharp-shinned hawk
Black-shouldered kite	Pallid bat
Cooper's hawk	Ringtail

Blue oak woodland (Blue Oak Woodland)

Black-shouldered kite	Pallid bat
Cooper's hawk	Ringtail
Sharp-shinned hawk	

Central coast arroyo willow riparian forest (Willow riparian)

Red-legged frog	Cooper's hawk
Northwestern pond turtle	Sharp-shinned hawk
Black-shouldered kite	Ricksecker's water scavenger beetle
Saltmarsh common yellowthroat	

Central coast live oak riparian forest (Coast live oak riparian forest)

Black-shouldered kite	Pallid bat
Cooper's hawk	Ringtail
Sharp-shinned hawk	

White alder riparian forest (White alder riparian forest)

Northwestern pond turtle	Cooper's hawk
California red-legged frog	Sharp-shinned hawk
Foothill yellow-legged frog	Ringtail

Sycamore alluvial woodland (Sycamore alluvial woodland)

Alameda whipsnake	Cooper's hawk
Northwestern pond turtle	Sharp-shinned hawk
California red-legged frog	Black-shouldered kite
Foothill yellow-legged frog	

Northern (Franciscan) coastal scrub (Coastal scrub)

Alameda whipsnake	Sharp-shinned hawk
Coastal western whiptail	Loggerhead shrike
Coast horned lizard	

Northern mixed chaparral (Northern mixed chaparral)

Coastal western whiptail	Loggerhead shrike
Coast horned lizard	

TABLE 3-3: POTENTIALLY OCCURRING SPECIAL STATUS WILDLIFE SPECIES BY HABITAT ON THE ALAMEDA WATERSHED - Continued

VEGETATION COMMUNITY NAME (WILDLIFE HABITAT NAME)

Chamise chaparral (Chamise chaparral)

Coast horned lizard	Loggerhead shrike

Non-native grassland (Annual grassland)

Ferruginous hawk	American badger
Prairie falcon	Callippe silverspot butterfly
Black-shouldered kite	Burrowing owl
Loggerhead shrike	Western spadefood toad
Golden eagle	California tiger salamander
California horned lark	

Non-native grasslands: San Antonio grasslands (San Antonio grasslands)

San Joaquin kit fox	American badger
Ferruginous hawk	Callippe silverspot butterfly
Prairie falcon	Burrowing owl
Black-shouldered kite	Western spadefoot toad
Loggerhead shrike	Short-eared owl
Golden eagle	California tiger salamander
California horned lark	

Valley needlegrass grassland (Perennial grassland)

Ferruginous hawk	American badger
Prairie falcon	Callippe silverspot butterfly
Black-shouldered kite	Burrowing owl
Loggerhead shrike	Western spadefoot toad
Golden eagle	California tiger salamander
California horned lark	

Serpentine-substrate perennial grasslands (Serpentine-substrate perennial grasslands)

Bay checkerspot butterfly	Ferruginous hawk
Opler's longhorn moth	Prairie falcon
Black-shouldered kite	Burrowing owl
Loggerhead shrike	Western spadefoot toad
Golden eagle	California tiger salamander
California horned lark	Serpentine phalangid
American badger	

Coastal and valley freshwater marsh (Fresh emergent wetland)

Tricolored blackbird	California red-legged frog
Western grebe	Northwestern pond turtle
Great blue heron	Ricksecker's water scavenger beetle

TABLE 3-3: POTENTIALLY OCCURRING SPECIAL STATUS WILDLIFE SPECIES BY HABITAT ON THE ALAMEDA WATERSHED - Continued

VEGETATION COMMUNITY NAME (WILDLIFE HABITAT NAME)

Riverine (Riverine)	
Bald eagle	Great blue heron
Northwestern pond turtle	Great egret
California red-legged frog	Snowy egret
Foothill yellow-legged frog	Ricksecker's water scavenger beetle
Pond or reservoir - open water (Lacustrine - open water)	
Aleutian Canada goose	Western grebe
Osprey	Northwestern pond turtle
Pond or reservoir - shoreline (Pond or reservoir - shoreline)	
Bald eagle	Great egret
Northwestern pond turtle	Snowy egret
California red-legged frog	Black-crowned night heron
Foothill yellow-legged frog	California tiger salamander
Western grebe	Ricksecker's water scavenger beetle
Great blue heron	

SOURCE: Compiled by Diane Renshaw and Environmental Science Associates, 1993.

TABLE 3-4: SPECIAL STATUS SPECIES PROTECTION CLASSIFICATION

Federal Status	
Endangered	Species in danger of extinction throughout all or significant portion of its range.
Threatened	Species likely to become endangered within foreseeable future throughout all or significant portion of its range.
Category 1	Candidate information now available indicates that listing may be appropriate with supporting data currently on file.
Category 1	Candidate information now available indicates that listing may be appropriate with supporting data currently on file; species presumed extinct.
Category 2	Candidate information now available indicates that listing may be appropriate but supporting data are not currently on file.
Category 2	Candidate information now available indicates that listing may be appropriate but supporting data are not currently on file; species presumed extinct.
Category 3a	Non-candidate previously considered candidate but now extinct.
Category 3b	Non-candidate previously considered but not valid taxonomically.
Category 3c	Non-candidate previously considered candidate but now too widespread or not threatened.
California State Status	
Endangered	Species whose continued existence in California is jeopardized.
Threatened	Species, although not presently threatened with extinction, is likely to become endangered in the foreseeable future.
Rare	Species which may become threatened in the foreseeable future.
Special Concern	Animal species with California breeding populations that may face extinction in the near future.
Fully Protected	Fully protected species include those that are under Sections 3511, 4700, 5050, and 5515 of the California Fish and Game Code.
State Special Animals	No official status, but selected by CDFG biologists as "watch list" taxa.

SOURCE: Environmental Science Associates, Inc.

watched. By so listing a species, the CDFG draws attention to the potential for future designations of such species to a more protected status.

The Federal Migratory Bird Treaty Act of 1919, 1972, and 1976 prohibits the harming of any species listed in the act (see Code of Federal Regulations, 50 CFR 10.12.). The California Department of Fish and Game Code Section 3503 states that it is "unlawful to take, possess, or needlessly destroy the nest or eggs of any bird" and section 3503.5 states "it is unlawful to take, possess or destroy any birds in the Order of Strigiformes (owls) or Falconiformes (birds of prey) or to take, possess, or destroy the nest or eggs of any such bird". The Bald Eagle Protection Act of 1940, as amended, affords protection to bald eagles and golden eagles against direct take of birds or nests, or possession of any part thereof. "Fully Protected" species listed in California Fish and Game Code Sections 3511 (birds), 4700 (mammals), 5050 (reptiles, amphibians), and 5515 (fish) are protected against take or possession, except as provided for in that law.

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SPECIAL STATUS WILDLIFE SPECIES DESCRIPTIONS

INVERTEBRATES

Opler's longhorn moth (*Adella oplerella*), a Category 2 candidate for Federal listing, occurs in serpentine grassland habitat, where its larval foodplant, *Platystemon californicus*, grows (Arnold 1993). This species occurs at scattered localities in Marin, San Francisco, and Santa Clara counties. Further studies are needed to determine species presence and population numbers.

Bay Checkerspot butterfly (*Euphydryas editha bayensis*), federally listed as endangered, is restricted to isolated patches of native grasslands on serpentine soil which support an abundance of the larval food plants namely, *Orthocarpus densiflorus* and *Plantago erecta*. North-facing slopes are usually favored except in wet years when south-facing slopes tend to be preferred. Several plants provide nectar for adult checkerspots, including *Lasthenia cryostoma*, *Layia platyglossa*, *Linanthus androsaceus*, and *Lomatium* sp. Bay checkerspot populations are known from similar habitat to the south of Calaveras Reservoir. Further studies are needed to determine species presence and population size on the Alameda Watershed.

Serpentine phalangid (*Sitalcina serpentinea*), listed by the CDFG as a sensitive species, occurs primarily in serpentine habitats, including grasslands and oak woodland, as well as redwood, broadleaf evergreen (Ubick and Briggs 1989). This species is more widespread than other harvestmen in the Bay Area, with occurrences in Contra Costa, Santa Clara, Santa Cruz, San Mateo, and San Benito counties. In Santa Clara County it has been observed from the Silver Creek Hills and Metcalf Canyon (Arnold 1993). Suitable habitat is likely within the Alameda Watershed.

Unsilvered fritillary butterfly (*Speyeria adiaste adiaste*), a Category 2 candidate for federal listing, feeds on *Viola pedunculata*. This species is generally associated with grassland pockets in or near redwood-oak woodlands (Arnold 1993). Once occurring in the southern portion of the San Francisco Peninsula from San Mateo south to Santa Clara and Monterey, this butterfly now occurs along the western hills of the Santa Clara Valley and in the Santa Cruz Mountains.

Calippe silverspot butterfly (*Speyeria callippe callippe*), a Category 1 Candidate for federal listing, occurs in coastal grasslands on its larval foodplant, *Viola pedunculata*. Adults have been observed using various thistles (*Cirsium*) and mint (*Monardella*) for nectar. Once widespread throughout the Bay area, this butterfly is now known only from San Bruno Mountain in San Mateo County. Populations within the Livermore Valley are considered to be intermediate between two populations of silverspot butterflies, one population restricted to the Bay Area, and the second, more common population, which occurs in central and southern California. Further studies are needed to determine species presence and population size in the watershed.

BIRDS

Western grebe (*Aechmophorus occidentalis*), a special status animal in California, nests on large open water lakes with a fair depth of water bordered by tules or rushes (Grinnell, 1944). This species is resident throughout the state, and, from September to April, will inhabit larger bays and the ocean. There is a nesting colony of approximately 60 pairs on San Antonio Reservoir. This colony suffered heavy predation by corvids in the Spring of 1993.

American white pelican (*Pelecanus erythrorhynchos*), a California Species of Concern (nesting colonies), winters in California on bays, lakes and reservoirs feeding on fish. During the breeding season protected islets and shoreline cover are used for nesting and roosting. During non-breeding seasons river sloughs and seacoast bays are used. Both the Calaveras and the San Antonio Reservoirs are possible wintering sites, and birds have been observed in the area.

Aleutian Canada goose (*Branta canadensis leucopareia*), federally listed as threatened, is known to winter in the Sacramento and Central Valleys of California. This species feeds in flood-irrigated fields, with a strong preference for harvested corn fields when available. Rice stubble, green barley, and non-irrigated pastures are also used for foraging. Night roosting usually occurs in large marshes, flooded fields, and stock ponds, out of reach of predators. There is a reported wintering population southwest of Calaveras Reservoir (USFWS 1991).

Great blue heron (*Ardea herodius*), a Special Status Animal (rookeries), is a year-round resident throughout California, in and around reservoirs, streams, and lakes with trees for nesting. This species forages in slow-moving streams with adjacent wetlands, feeding on small fish, amphibians, invertebrates and young birds. There is a known nesting rookery in San Antonio Reservoir and a reported rookery at Calaveras Reservoir.

Cooper's hawk (*Accipiter cooperi*), a California Species of Concern (nesting populations), is a small bird hunter, hunting on the edges of forests in broken forest and grassland habitats where passerines forage for seeds and insects. This species nests in heavily forested areas near a water source. Some research sites on nesting Cooper's hawks show the nests rarely more than a quarter of a mile away from water, whether it is a cattle tank, stream, or seep (Snyder, 1975). Typical trees used by Cooper's hawks are cottonwoods, coast live oaks, and black oaks (Call 1978). This species also nests in second-growth conifer stands or deciduous riparian areas. Both San Antonio and Calveras Reservoirs contain habitat for this species.

Sharp-shinned hawk (*Accipiter striatus*) is listed as a California Species of Concern (nesting populations). Although the breeding populations are declining in California, there are other populations country-wide that do not warrant a federal listing. This species, like other raptors and birds in general, is covered by California Code 3503 and 3503.5, which prohibits the taking or destroying of nest or eggs of any bird and prohibits the taking or destroying of any bird, or nest in the order of Falconiformes (falcons, kites, and hawks) and Strigiformes (owls). This species breeds in northern half of the state or south along mountain ranges (Grinnell 1944), and is a winter visitor, from September to April. Sharp-shinned hawks are small bird hunters, using forested areas and forest edges along grassland areas for hunting. Sharp-shinned hawks have

been observed around San Antonio and Calaveras Reservoirs and in the area between the two reservoirs (Peeters pers. comm.).

Northern harrier (*Circus cyaneus*), a California Species of Concern (nesting populations), nest and forage along wet meadows, slough, savanna, or prairie and marshes, feeding on small mammals, such as California vole (*Microtus californicus*) and western harvest mice (*Reithrodontomys megalotis*). The territory for this species is often a minimum of 10-20 acres foraging area. Destruction of marsh and adjacent upland habitat is the primary reason for the decline in populations of this species. Individuals have been observed in the San Antonio Reservoir area (Peeters, pers. comm.)

Golden eagle (*Aquila chrysaetos*), is designated a California Species of Concern, a State Fully Protected species, and is protected under the Federal Bald Eagle Protection Act. They can occur in the entire length of the state, mostly east of the narrow humid coast belt (Grinnell 1944). This species requires large, open foraging areas near hilly or windy areas. Nesting areas on cliffs or in oak trees are often used year after year. Prey species include black-tailed jackrabbit, California ground squirrel, and other small mammals. Habitat destruction (conversion of grasslands to agriculture), shooting, secondary poisoning, and human disturbance are major threats to this species. There are approximately eight pairs around the San Antonio Reservoir and an unknown number of pairs around Calaveras Reservoir (Peeters, pers. comm.).

Ferruginous hawk (*Buteo regalis*), a Category 2 candidate for federal listing and a California species of concern, like other raptors is also protected under California Code 3503 and 3503.5. This species occurs in the Central Valley during the winter, arriving in September and leaving mid-April, frequenting open grassland areas, sagebrush flats, desert scrub, and fringes of pinion-juniper habitats. Ferruginous hawks roost in open areas, often using utility poles. The main threats to this species are conversion to agriculture and human harassment. This species has been observed around the northern part of San Antonio Reservoir (Peeters, pers. comm.).

Black-shouldered kite (*Elanus caeruleus*), California Fully Protected, is a resident of California, but shifts about seasonally in accordance with food supplies. Prior to 1895 this species was common-to-widespread in valley and lower foothill territory, but now is rare in many sections of the state (Grinnell and Miller, 1944). This species forages in wetlands and open brushlands, usually near water and streams. Oak woodlands, valley oak or live oak, or trees along marsh edges are used for nesting sites. The nest made by this species is a frail platform of sticks, leaves, weed stalks, and similar materials located in tree or bush. A combination of habitats is essential, including open grasslands, meadows or marshes for foraging, and isolated dense topped trees for perching and nesting. The destruction of wetlands is the primary threat to this species. This species has been observed around the southern part of San Antonio Reservoir (Peeters, pers. comm.).

Bald eagle (*Haliaeetus leucocephalus*), federal and state listed as an endangered species, is also protected under the Bald Eagle Protection Act and as a California Fully-Protected species. It uses most of California's lakes, reservoirs, river systems, and coastal wetlands. They forage on large bodies of water, or free-flowing rivers with abundant fish. This species will also opportunistically hunt sick or wounded ducks across water, and will feed on carrion. Snags or

large, old growth trees are required for perching. This species has been observed around the southern part of San Antonio Reservoir (Peeters, pers. comm.).

Osprey (*Pandion halieetus*), a California Species of Concern (nesting populations), occurs along the coast of California all year long, and on large inland lakes and reservoirs, from February to October. This species requires large open snags to perch on, tall trees with open canopies, and feeding grounds within 15 miles. The sole diet for this species is fish. This species has been observed foraging around the southern part of San Antonio Reservoir (Peeters, pers. comm.).

Prairie falcon (*Falco mexicanus*), a California Species of Concern (nesting birds), nests in areas with cliffs and forages in dry open terrain such as open grassland, and chaparral, and will use fallow agricultural lands and pastures (Grinnell and Miller, 1944). Although this species does not migrate as other falcons do, prairie falcons will move to a new region where they can find steady food for the season. The main threat to this species is human disturbance and loss of foraging lands. This species has been observed foraging around the southern part of San Antonio Reservoir (Peeters pers. comm.)

Burrowing owl (*Speotyto cunicularia*), a California species of concern (breeding populations), require burrows to nest in. These holes, usually dug by small mammals in loose dirt, will often be enlarged by the owls themselves, and are often reused, not necessarily by the same pair (Zarn, 1974). Several burrows might be renovated but only one will be in primary use, with a few satellite burrows around for escaping, perching and observation. Dirt mounds, used for observation and hunting perches, are another habitat requirement. This species will use edges around agricultural fields, golf courses, and airports where there is little or sparse vegetation and raised elevations, hunting small rodents, birds, lizards and insects. Conversion of grassland and pastureland to agriculture and the eradication of ground squirrels through the use of poison has depleted the population of this species. This species has been observed around the northern part of San Antonio Reservoir (Peeters, pers. comm.).

California Horned Lark (*Eremophila alpestris actia*), A Category 2 candidate for federal listing, is a year-long resident in most of California except the Sierras during winter (Grinnell and Miller, 1944). It is usually found in open habitat, such as grassland and agricultural areas, where trees and shrubs are absent. This species has been observed from sea level to above treeline in various habitats, such as grasslands, deserts and alpine dwarf-shrub habitat. It uses grasses, shrubs, forbs, rocks, litter, clods of soil, and other surface irregularities for cover from predators. This species has been observed around the northern part of San Antonio Reservoir and on Poverty Ridge near Calaveras Reservoir (Peeters, pers. comm.).

Loggerhead shrike (*Lanius ludovicianus*), is a Category 2 Candidate for federal listing and a California Species of Concern. This shrike is common throughout California in the lowlands and the foothills. This species occurs in open habitats, such as grasslands and agricultural fields, using shrubs, trees, posts, fences, and utility lines for perching surfaces, and barbed wire or thorns for caching and displaying prey. Habitats with little or no human disturbance are preferred. Edges of denser habitats are sometimes used. Insecticides and habitat loss have caused population decreases. This species has been observed around the northern part of San Antonio Reservoir and around the eastern side of Calaveras Reservoir (Peeters, pers. comm.).

Tricolored blackbird (*Agelaius tricolor*), a California species of concern and a Category 2 candidate for federal listing, are partly migratory within the Sacramento-San Joaquin drainage system (Grinnell and Miller, 1944). During the nesting season this species require freshwater marshes with abundant tules to stake out territories and to build protected nests. If tules are unavailable they will also use sedges, nettles, willows, thistles, or mustard. An area for minimum number of 50 pairs seem to the requirements for choosing a site. Typical foraging requirements include flooded lands, margins of ponds, and grassy fields, in summer and winter. Human management of water supplies has led to a decline in population numbers. Breeding colonies of this species has been observed in San Antonio Reservoir and on the side of Calaveras road (Peeters, pers. comm.).

Saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*), is a Category 2 Candidate for federal listing and a California Species of Concern. A resident of the San Francisco Bay marshes, the yellowthroat inhabits both salt and freshwater marshes in the summer (Grinnell 1944). Salt marshes are inhabited during the fall and winter. Tall grasses, tule patches, and willow thickets are used during the breeding season for nesting. Both foraging and nesting grounds are within ten feet of the ground. Grinnell and Miller (1944) reported nesting occurrences around the sloughs of the bay from southern Sonoma County down to San Jose and winter occurrences in the coastal marshes from the San Francisco Bay region down to San Diego. Loss of breeding and wintering habitat threatens this species.

MAMMALS

Berkeley kangaroo rat (*Dipodomys heermanni berkleyensis*), a State Special Animal, inhabits annual grassland, coastal scrub, mixed chaparral, and early successional stages of hardwood habitats. There are historic records of this animal from the vicinity of Calaveras Dam (Beeman, pers. comm.). A trapping survey is needed to determine the current status of the population

Townsend's western big-eared bat (*Plecotus townsendii townsendii*), a Category 2 Candidate for federal listing and a California Species of Concern, requires caves, mines, tunnels, or buildings for roosting. Maternity roosts are typically warm. Roosting sites are an important limiting factor; species has high site fidelity and is extremely sensitive to disturbance at the roost. This species has been reported from the adjacent East Bay Regional Park (Winters, pers. comm.).

Pallid bat (*Antrozus pallidus*), a California Species of Concern, inhabits a wide variety of lowland habitats. It is a colonial rooster, with a minimum group size necessary for metabolic economy and successful rearing of young. Preferred roosts are caves, crevices, mines, and hollow trees and buildings. The species is very sensitive to disturbance at the roost (Zeiner, et. al., 1990). A colony of unknown size has been observed at Goat Rock near Calaveras Reservoir (Peeters, pers. comm.), and individuals have been sighted at the Calaveras Road bridge (Winters, pers. comm.). Further studies within the vicinities of San Antonio Reservoir and Calaveras Reservoir are needed to determine species population in the watershed.

Western mastiff bat (*Eumops perotis*), a Category 2 Candidate for federal listing and a California Species of Concern, is a crevice-dwelling animal that favors open, semi-arid habitats with sparse vegetation. Natural roost sites are exfoliating cliff faces and remote rocks, although

over half of the known roost sites in California are in old barns and abandoned buildings. Further studies are needed to determine habitat suitability and species occurrence.

Ringtail (*Bassariscus astutus*), a California Fully Protected Species, occurs in various riparian habitats, brush stands of forest and shrub habitats. This species uses hollow trees, logs, snags, cavities in talus and other rocky areas, and is usually found within one kilometer of water. One individual has been seen outside the watershed boundary (Peeters, pers. comm.). Further studies within the vicinities of San Antonio Reservoir and Calaveras Reservoir are needed to determine species occurrence in the watershed.

Badger (*Taxidea taxus*), a California Species of Concern, occurs primarily in grassland habitats with friable soils. A year-round resident, badgers prey on other fossorial (earth burrowing) species. Threats to this species are habitat loss, trapping, and secondary poisoning. Grassland of both reservoirs is suitable habitat for this species.

MANAGEMENT MAMMALS

Tule elk (*Cervus elaphus nannodes*) moved into the San Antonio Reservoir area after being released by California Department of Fish and Game in Grant Ranch County Park in 1978. The herd of nine elk traveled northward 18 kilometers to the vicinity of San Antonio Reservoir where they were monitored from 1979 to 1986. The herd ranges in the southern part of the reservoir, from north of McGuire Peaks to San Antonio Creek and west of Indian Creek. By the end of 1986 there were 29 elk in the local herd. Tule elk are a native species with drastically reduced populations throughout the state. An introduction/reintroduction program has been carried out by CDFG in recent years. Tule elk are classified as a game animal but no take is permitted by CDFG at this time.

Wild pigs (*Sus scrofa*) have been in the Calaveras Reservoir since the 1920's (Schauss and Corelli, 1992). A survey conducted during 1990 and 1992 focused on the wild pig population in the Calaveras Reservoir area. There are some pigs moving into the San Antonio Reservoir area along Williams Gulch, but the majority of the population remains in the vicinity of the Calaveras Reservoir. There are approximately 60 individuals within the area. Wild pigs are classified as a game animal and can be taken with a permit.

4.0 FISHERIES

REGIONAL OVERVIEW

The two reservoirs (Calaveras and San Antonio) and their tributary streams, within the Alameda Watershed, primarily contain warmwater fishery resources. Historically, the Alameda Watershed contained anadromous steelhead trout, rainbow trout, and other native fishes. However, due to the watershed's close proximity to highly urbanized areas of the San Francisco Bay Area, with its continued trend towards urban sprawl, the fishery resources have declined dramatically. According to existing reports, a self-sustaining steelhead trout population was extirpated by the late 1950's. Consequently, the Alameda Creek watershed has been managed by the California Department of Fish and Game as a non-anadromous fishery and a "put-and-take" rainbow trout fishery was established in the Niles Canyon area of Alameda Creek in 1974, with annual trout plants of 30,000 fish. Today, a few steelhead trout attempt to immigrate during wet years, although both low flows and high water temperatures provide little in the way of salmonid habitat. Instead, warmwater fish species such as minnows, suckers, catfish, bass and sunfish predominate in the streams and reservoirs. Many of these species, such as the bass and sunfishes, are exotic species. These species quite probably prey on the native fishes, as they do in other California systems, and thus have contributed to the decline in the native fish species. Within the Alameda Watershed, Arroyo Hondo Creek appears to offer the best trout habitat. Unfortunately, little information is available, although old records indicate that there may be a "landlocked" strain of steelhead trout in this creek. Further site specific biological information is needed to assess the management needs of the steelhead and/or rainbow trout within the Alameda Watershed.

RESOURCE DESCRIPTION

Figure 4-1, Aquatic Habitats of the Alameda Watershed, shows the primary tributary streams associated with the watershed reservoirs. Table 4-1 indicates the "Aquatic Habitat Number" that identifies each stream reach or reservoir; provides a brief description of the habitat type and reported presence of coldwater fisheries (e.g. rainbow trout and steelhead); and gives the classification based on the Aquatic Diversity Management Area (ADMA) Classification System now in use by the Department of Fish and Game and the Environmental Protection Agency. The ADMA classification system is being developed to provide a statewide system focused on protection of California's native aquatic fauna. The primary management goal for an ADMA is the protection of aquatic biodiversity; these areas are roughly equivalent to "Significant Natural Areas" recognized by the Department of Fish and Game. Table 4-2 summarizes the ADMA

TABLE 4-1: AQUATIC HABITATS OF THE ALAMEDA WATERSHED

Aquatic Habitat No.	Name	Classification	Description
1A	San Antonio Creek Below San Antonio Reservoir	F2221	Rainbow trout have been collected, although limiting factors appear to be high water temperatures, spawning gravel, rearing pools, and low flows. Otherwise a warmwater fish habitat.
1B	San Antonio Reservoir	F1222	Reservoir, thermally stratified, with warmwater fish species and rainbow trout.
1C	San Antonio Creek above San Antonio Reservoir	F2210	Rainbow trout have been collected, although limiting factors appear to be spawning gravel, rearing pools, and low flows. Otherwise a warmwater fish habitat.
2A	Alameda Creek below confluence with Calaveras Creek	F2240	Steelhead and rainbow trout have been collected, although limiting factors appear to be high water temperatures and low flows. Otherwise a warmwater fish habitat.
2B	Alameda Creek above confluence with Calaveras Creek	A2422	Steelhead and rainbow trout have been collected, although limiting factors appear to be high water temperatures and low flows. Otherwise a warmwater fish habitat.
3A	Calaveras Creek below Calaveras Reservoir	F2221	Steelhead and rainbow trout have been collected, although limiting factors appear to be high water temperatures and low flows. Otherwise a warmwater fish habitat.
3B	Calaveras Reservoir	F1222	Reservoir, thermally stratified, with warmwater fish species and trout.
3C	Calaveras Creek above Calaveras Reservoir	F2210	Rainbow trout have been collected, although limiting factors appear to be spawning gravel, rearing pools, and low flows. Otherwise a warmwater fish habitat.
4	Welch Creek	F2260	Unknown, but may provide food source for fish in Alameda Creek.
5	Arroyo de Laguna Creek	F2250	Rainbow trout have been collected, although limiting factor appears to be high water temperatures. Otherwise a warmwater fish habitat.
6	Tributary to Vallecitos Creek	F2160	Intermittent; probably has limited, if any, fishery resources value.
7	Vallecitos Creek	F2160	Intermittent; probably has limited, if any, fishery resources value.

TABLE 4-1: AQUATIC HABITATS OF THE ALAMEDA WATERSHED

Aquatic Habitat No.	Name	Classification	Description
8	Indian Creek	F2170	Rainbow trout have been collected, although limiting factors appear to be spawning gravel, rearing pools, and low flows. May provide fish food sources for reservoir fishes.
9	La Costa Creek	F2210	Rainbow trout have been collected, although limiting factors appear to be spawning gravel, rearing pools, and low flows. May provide fish food sources for reservoir fishes.
10	Apperson Creek	F2150	Dry; probably no fish value.
11	First Tributary to Alameda Creek	F2160	Dry; probably no fish value.
12	Second Tributary to Alameda Creek	F2160	May provide fish food sources for Alameda Creek. There are bank erosion problems.
13	Third Tributary to Alameda Creek	F2160	May provide fish food sources for Alameda Creek. Bank erosion problems exist, which may affect Alameda Creek.
14	Fourth Tributary to Alameda Creek	F2160	Dry; probably no fish value.
15	Fifth Tributary to Alameda Creek	F2160	Bank erosion problems which may affect Alameda Creek.
16	Arroyo Hondo Creek	F2210	Rainbow trout and, perhaps, a "landlocked" steelhead trout population exist in this creek. It is the only creek in the Alameda Watershed which appears to have some real potential as a wild trout stream.
17	First Tributary to Arroyo Hondo Creek	F2170	Dry; probably no fish value.
18	Second Tributary to Arroyo Hondo Creek	F2170	May provide fish food sources for Arroyo Hondo Creek.
19	ThirdTributary to Arroyo Hondo Creek	F2170	Dry; probably no fish value.
20	Marsh Creek	F2160	Almost dry; probably no fish value.
21	Haynes Creek	F2160	Dry; probably no fish value.
22	Indian Joe Creek	F2170	May provide fish food sources for Alameda Creek.

SOURCE: A.A. Rich and Associates, 1993.

classification scheme for the Alameda Watershed streams and reservoirs. A full description of the ADMA classification system is given in Appendix B.

For purposes of discussion, the fishery resources of the Alameda Watershed are divided into the following two systems: San Antonio Reservoir and its tributary streams; and, Calaveras Reservoir and its tributary streams. Table 4-3 summarizes the fish species that have been collected on the Alameda Watershed.

San Antonio Reservoir and its Tributary Streams

San Antonio Reservoir (Aquatic Habitat Number 1B) is a thermally stratified reservoir in which rainbow trout, California roach, brown bullhead, bluegill, largemouth bass, and prickly sculpin have been collected. San Antonio Reservoir and its perennial tributaries, San Antonio Creek above the reservoir, Indian Creek, and La Costa Creek (Aquatic Habitat Numbers 1C, 8, and 9) contain a self-sustaining rainbow trout population. Historically, steelhead trout used the San Antonio Creek drainage for spawning and rearing. By the early 1960's, steelhead trout were essentially eradicated as a result of water regulation, channel alteration, water quality degradation and barrier construction. The rainbow trout populations inhabiting the streams above San Antonio Reservoir may be of steelhead trout origin. Although rainbow trout have been collected in San Antonio Creek below the reservoir, the creek was dry during the 1993 site visit (Rich, 1993). Apperson Creek (Aquatic Habitat Number 10) was dry and offers no fish habitat.

Calaveras Reservoir and its Tributary Streams

Calaveras Reservoir (Aquatic Habitat Number 3B) is a thermally stratified reservoir in which rainbow trout, golden shiner, Sacramento sucker, brown bullhead, Sacramento perch, bluegill, black crappie, largemouth bass, and prickly sculpin have been collected. Calaveras Reservoir comprises two general thermal layers, a warm top layer and a cold water bottom layer. The reservoir tends to be best suited for warmwater fishes, although the rainbow trout are endemic.

Calaveras Creek (Aquatic Habitat Number 3C) above Calaveras Reservoir provides habitat for rainbow trout, California roach, and various sunfish species. Calaveras Creek (Aquatic Habitat Number 3A) downstream of the reservoir is often not-continuous, resulting in poor-quality fish habitat. Fish species which have been collected in Calaveras Creek, downstream of the reservoir, include rainbow trout, California roach, Sacramento sucker, threespine stickleback and, bluegill.

TABLE 4-2. FISHERY RESOURCES CLASSIFICATION SCHEME FOR THE STREAMS AND RESERVOIRS OF THE ALAMEDA WATERSHED

- SAN ANTONIO RESERVOIR, COLDWATER, THERMALLY STRATIFIED (F1222)
    - San Antonio Creek
        - Below San Antonio Reservoir, Regulated (F2221)
        - Above San Antonio Reservoir, Unregulated (F2210)
        - La Costa Creek, Unregulated (F2210)
    - Indian Creek, Unregulated (F2210)
    - Apperson Creek, Intermittent, Unregulated (F2150)

- CALAVERAS RESERVOIR, COLDWATER, THERMALLY STRATIFIED (F1222)
    - Calaveras Creek
        - Above Calaveras Reservoir, Unregulated (F2210)
        - Below Calaveras Reservoir, Regulated (F2221)
        - Marsh Creek, Intermittent, Unregulated (F2160)
        - Arroyo Hondo Creek, Unregulated (F2210)
            - Intermittent Tributaries to Arroyo Hondo Creek, Unregulated (F2170)

- ALAMEDA CREEK
        - Upstream of Calaveras Creek, Unregulated (A2422)
        - Downstream of Calaveras Creek, Regulated (F2240)
        - Indian Joe Creek, Intermittent, Unregulated (F2170)
        - Welch Creek, Unregulated (F2260)
        - Haynes Creek, Intermittent, Unregulated (F2160)
        - Arroyo de Laguna Creek, Regulated (F2250)
            - Vallecitos Creek, Intermittent, Regulated (F2160)
                - Tributary to Vallecitos Creek, Intermittent, Regulated (F2160)
        - Intermittent Tributaries to Alameda Creek (F2160)

Note: Additional ADMA's have been added to the ARTIFICIAL HABITATS Classification (i.e., F0000) specifically for this project. These ADMA's will probably change, once a suitable classification scheme has been finalized for regulated waters.

SOURCE: A. A. Rich and Associates, 1993.

TABLE 4-3: SENSITIVE FISH SPECIES REPORTED FROM STREAMS AND RESERVOIRS OF THE ALAMEDA WATERSHED

Common Name	Scientific Name	Aquatic Habitat No.[1]	References
Lamprey	*Entosphenus tridentatus*	2a	Aceituno et al., 1974, CAS, 1974; CFG, 1973e
Threadfin Shad	*Dorosoma petense*	2a	Aceituno et al., 1974
Steelhead Trout	*Oncoryhnchus mykiss*	2a, 2b	CFG, 1937; Scoppetone and Smith, 1978
Rainbow Trout	*Oncoryhnchus mykiss*	1a, 1b, 1c, 2a, 2b, 3a, 3b, 3c, 5, 8, 9, 16	Aceituno et al., 1974; CAS, 1974; CFG, 1945, 1957, 1968, 1973a,b,c, 1974a, 1975d,e,f, 1977b, 1979c, 1988a; Scoppetone and Smith, 1978; Smith, 1978
Hitch	*Lavinia exilicauda*	2a, 5	Aceituno et al., 1974; CAS, 1974; CFG, 1973a,e,g, 1975i, 1976a,f; Snyder, 1904; USFWS, 1975a,b
California Roach	*Lavinia symmetricus*	1b, 2a, 2b, 3a, 3c, 5, 16	CFG, 1957, 1976a,f; Scoppetone and Smith, 1978; Smith, 1978; Snyder, 1904; USFWS, 1975a,b
Sacramento Blackfish	*Orthodon microlepidotus*	2a	CFG, 1973e
Sacramento Squawfish	*Ptychocheilus grandis*	2a, 5	Aceituno et al., 1974; CAS, 1974; CFG, 1957, 1973a,e, 1974a, 1976b,f, 1986a; Smith, 1978; Snyder, 1904
Golden Shiner	*Notemigonus crysoleucas*	3b	CFG, 1973b
Goldfish	*Carassius auratus*	2a, 5	Aceituno et al., 1974; CFG, 1973e, 1976b,f; USFWS, 1975a,b
Carp	*Cyprinus carpio*	2a, 5	Aceituno et al., 1974; CAS, 1974; CFG, 1973a,e; 1974g, 1976a,f, 1979c, 1986a; USFWS, 1975a,b
Sacramento Sucker	*Catostomus occidentalis*	2a, 2b, 3a, 3b, 5, 16	Aceituno et al., 1974; CAS, 1974; CFGa,b,c,d,e, 1976a,b,e,f, 1986a; Smith, 1989; Snyder, 1904
Brown Bullhead	*Ictalurus nebulosus*	1b, 2a, 3b	Aceituno et al., 1974; CFG, 1973a,b,c
White Catfish	*Ictalurus catus*	2a	Aceituno et al., 1974; CAS, 1974; CFG, 1974d, 1979

TABLE 4-3: SENSITIVE FISH SPECIES REPORTED FROM STREAMS AND RESERVOIRS OF THE ALAMEDA WATERSHED (Continued)

Common Name	Scientific Name	Aquatic Habitat No.[1]	References
Mosquitofish	*Gambusia affinis*	2a	Aceituno et al., 1974; CFG, 1973e
Threespine Stickleback	*Gasterosteus aculeatus*	1a, 2a, 3a	Aceituno et al., 1974; CFG, 1973e, 1988; Smith, 1978
Sacramento Perch	*Archoplites interruptus*	2a, 3b, 5	Aceituno et al., 1974; CAS, 1974; CFG, 1945, 1968, 1973b,c,e, 1976a,b; USFWS, 1975b
Bluegill	*Lepomis macrochirus*	1b, 2a, 3b, 3c, 5	Aceituno et al., 1974; CAS, 1974; CFG, 1957, 1968, 1973a,b,c,d,e, 1976a,f, 1979c
Green Sunfish	*Lepomis cyanellus*	2a, 3c, 5	Aceituno et al., 1974; CAS, 1974; CFG, 1957, 1973e, 1976a,f, 1978; Smith, 1978; USFWS, 1975b
Black Crappie	*Pomoxis nigromaculatus*	2a, 3b	Aceituno et al., 1974; CFG, 1968
Largemouth Bass	*Micropterus salmoides*	1b, 2a, 3a, 3b, 5	Aceituno et al., 1974; CFG, 1968, 1973a,b,c,d,e, 1979c, 1988a; USFWS, 1975a,b
Prickly Sculpin	*Cottus asper*	1a, 1b, 2a, 2b, 3a, 3b, 5, 16	Aceituno et al., 1974; CAS, 1974; CFG, 1973e, 1976a,b,f; Smith, 1978; Snyder, 1904
Riffle Sculpin	*Cottus gulosus*	2a	CFG, 1973a

1 See Table 4-1

SOURCE: A. A. Rich and Associates, 1993.

Alameda Creek, both above and below the confluence with Calaveras Creek, contains primarily warmwater minnows, bass and sunfishes, although rainbow and steelhead trout have been collected, as well. However, human-induced perturbations (water regulation, channel alteration, water quality degradation and barrier construction) have resulted in a habitat which is not hospitable to salmonid species.

Arroyo Hondo Creek (Aquatic Habitat Number 16) offers the best resident rainbow trout habitat in the Alameda Watershed. Arroyo Hondo Creek is used as a spawning and nursery area by rainbow trout and contains several minnow species (Table 1). It contains some large pools and may be cooler than the other creeks in the watershed.

No fishery resources information is available for Welch Creek (Aquatic Habitat Number 4), Vallecitos Creek and its tributary (Aquatic Habitat Numbers 6 and 7), the five tributaries to Alameda Creek (Aquatic Habitat Numbers 11, 12, 13, 14, 15), the three tributaries to Arroyo Hondo Creek (Aquatic Habitat Numbers 17, 18, 19), Marsh Creek (Aquatic Habitat Number 20), Haynes Creek (Aquatic Habitat Number 21), and Indian Joe Creek (Aquatic Habitat Number 22). Of these creeks, based on the 1993 site visit, only Welch Creek, the Alameda Creek tributaries, the second tributary to Arroyo Hondo, and Indian Joe Creek may offer value to fishes in the form of food resources. The other creeks offer little, if any, fish habitat value.

SENSITIVE RESOURCES

The important and sensitive fishery resources which exist in the Alameda Watershed include the anadromous steelhead trout and the resident rainbow trout. The California Department of Fish and Game is interested in rehabilitating Alameda Creek for steelhead trout. Further studies are needed to assess the population and status of the steelhead trout in Alameda Creek and the rainbow trout ("landlocked" steelhead trout) in Arroyo Hondo Creek. Although Bookman-Edmondson (1993) has just completed a study on the feasibility of restoring steelhead trout to Alameda Creek, the study focuses on habitat models, rather than the collection of on-site biological data. Potentially, one of the key problems in Alameda Creek is high water temperatures. The responses of both steelhead and rainbow trout to water temperature alterations are site-specific. Although, salmonids are typically temperate water species, there is a growing amount of literature demonstrating that, under special circumstances, some salmonids appear to grow well at higher than "optimum temperatures." The critical factors appear to be the amount of food present and/or thermal stratification (Rich, 1991; Smith, 1987). Thus, if there is not an adequate food base for the trout, lower water temperatures are required. Site specific

temperature-growth-food studies are needed to determine whether or not Alameda Creek would provide suitable habitat for steelhead trout.

REGULATORY FRAMEWORK

The regulatory framework for the Alameda Watershed from the fishery resources perspective includes the following:

The owner of any dam is responsible for releasing enough water to maintain fishery resources as specified in the California Department of Fish and Game Code Number 5937: (Passage of Water for Fish Below Dam):

> The owner of any dam shall allow sufficient water at all time to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around or through the dam, to keep in good condition any fish that may be planted or exist below the dam. During the minimum flow of water in any river or stream, permission may be granted by the department to the owner of any dam to allow sufficient water to pass through a culvert, waste gate, or over or around the dam, to keep in good condition any fish that may be planted or exist below the dam, when, in the judgment of the department, it is impracticable or detrimental to the owner to pass the water through the fishway.

Under the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act (Fish and Game Code 6902, Legislative declarations), improvement and increase in naturally spawning steelhead must be accomplished primarily through the improvement of stream habitat. Furthermore, existing natural steelhead trout habitat shall not be diminished further without offsetting the impacts of the lost habitat. The Legislature, declares as follows:

(a) It is the policy of the state to significantly increase the natural production of salmon and steelhead trout by the end of this century. The department shall develop a plan and a program that strives to double the current natural production of salmon and steelhead trout resources.

(b) It is the policy of the sate to recognize and encourage the participation of the public in privately and publicly funded mitigation, restoration, and enhancement programs in order to protect and increase naturally spawning salmon and steelhead trout resources.

(c) It is the policy of the state that existing natural salmon and steelhead trout habitat shall not be diminished further without offsetting the impacts of the lost habitat.

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5.0 FIRE HAZARD

REGIONAL OVERVIEW

There are several factors in the development of fire related issues such as fire history, distribution of fuel types, use of fire for resource enhancement, or potential damage from a wildfire. Weather and topography, in large part, determine the development of the fuels available to burn as well as the fire behavior when an ignition occurs. The pattern of development greatly influences the spatial distribution of a variety of values which are expected to be damaged from wildfire. In addition, the "lay of the land" in large part determines the magnitude of the visual impact from fire. For example, a fire in a hidden valley has a much different level of aesthetic sensitivity than a slope exposed to the view of Highway 680. The type and distribution of ignition sources also help determine the recent fire history. Because ignitions are most closely linked to human use and access, these become additional important factors to describe.

The Alamdeda Watershed's mediterranean climate is characterized by long, dry, hot summers that promote a high chance of ignition and a vegetation that is extremely drought resistance and adapted to frequent fires. The climate, coupled with a long history of grazing, has promoted an extensive cover of grass. Grazing is commonly practiced in the region including most adjacent and nearby parcels. Grassland coverage promotes the likelihood of fires since grass is easily ignited. The topography is quite convoluted, with several small slopes which are conducive to smaller fires. Generally, the watershed is shielded from view (with respect to surrounding population centers) and is, likewise, shielded from strong prevailing westerly winds. Calaveras Road extends along the western portion of the property and is a well-traveled alternative to Highway 680 in periods of traffic. Additional use (and ignition sources) inside SFWD lands are created by recreational use of East Bay Regional Park District Sunol Wilderness, as well as access to residences and a major population center to the west. Many values are impacted by fire, with water quality and quantity being central. While local vegetation is likely not to be harmed by fire, several pockets of development to the north, west, and southwest would sustain considerable damage should a fire occur.

RESOURCE DESCRIPTION

Resources which are related to fire hazard have been classified for this plan using the present fuel and site characteristics that contribute to potential fire behavior as well as the values at risk that would present special fire protection considerations. Two resource maps have been developed:

Figure 5-1, Fuel Model/Fuel Hazard Zones of the Alameda Watershed and Figure 5-2, Wildfire Severity Zones of the Alameda Watershed. The fuel model map includes six separate models, and is useful for estimating fire behavior and for refining management zones later in the planning process. Each fuel model is assigned a fuel hazard rating given the condition of the component natural community. The fire severity map is developed from three indices: dwelling density, slope, and fuel hazard rating. These indices are based on a methodology specified in The California Wildfire Severity Law (AB 337). In addition, this section describes the fire history of the watershed in terms of both the spatial and temporal distribution of fires.

Fuel Models

The process of selecting appropriate fuel models to accurately reflect on-site fuel characteristics is based on characteristic parameters of the fuel complex that drive fire behavior. These parameters include, but are not limited to:

(1) fuel loading (mass per unit area, live and dead, groups by particle size class)
(2) surface to volume ratio of each size class
(3) fuel particle bulk density
(4) fuel depth
(5) heat content of fuels
(6) moisture of extinction (the upper limit of moisture content beyond which fire will no longer spread)

An additional characteristic, important in regard to fire behavior but not explicitly treated in the models, is a description of the vertical continuity from surface to aerial fuels that provides a means for crown fires and subsequent spotting to develop.

Measurement of all the fuel parameters listed above is generally infeasible for the purpose of wildfire prediction. An alternative approach is to use prescribed fuel arrangements, called fuel models, that have been developed to represent most surface fuel complexes encountered in the United States. These fuel models contain all the numerical values for the fuel parameters needed for the fire spread model (BEHAVE) to predict fire behavior. Additional inputs to BEHAVE include site characteristics (e.g. slope) and environmental characteristics (e.g. wind) as well as interactions of the environment with the fuels (e.g. fuel moisture).

The fuel model classification system used in this study is derived from the development of fuel and fire behavior modeling done by the USDA Forest Service at the Intermountain Forest Fire Research Laboratory. The classification system provides specific descriptions of fuel complexes

on the watershed and provides the ability to model fire behavior under a variety of environmental scenarios; it can be used as a framework for developing site-specific management activities. It should be noted that this classification scheme works in a hierarchical fashion in relation to the fuel hazard layer used in the state-mandated fire severity mapping. Models 1, 2, and 3 are driven by herbaceous fuels and thus are all categorized as a "low" fuel hazard. Models 4 and 5 are driven by shrub fuels, and are categorized as a "medium" fuel hazard. Models 8, 9, and 10 are timbered fuel complexes deriving their primary fuels from tree litter and downed woody material, and are categorized as a "high" fuel hazard. A complete description of each of these fuel models can be found in Anderson (1982) and Rothermel (1983). It should be noted that the computer modeling procedure also provides the user with the ability to make appropriate changes to model parameters in order to more accurately represent on-site characteristics. This flexibility allows for relatively gross fuel models to be customized to individual areas to reflect significant differences in fuel characteristics that are likely to influence model output. The six models used in this study are briefly described below.

Grass Group

Model 1 - Short Grass - This model is represented by areas supporting low productivity grasslands such as serpentine grasslands, or more productive areas that have either been mowed or grazed prior to the onset of cure. Mean fuel bed height is one foot, with very little or no shrub or tree fuels present.

Model 2 - Timber with a Grass Understory - Fire spread in this model is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires, where herbaceous material, in addition to litter as well as dead and downed stemwood from open shrub or timber understory contribute to fire intensity. Vegetation types that fall into this model include open brushlands and blue oak savannah/woodland.

Model 3 - Tall Grass - Fires in this model type are the most intense of any in the grass group, and display high rates of spread under the influence of wind. Most of the ungrazed grasslands in the watershed, including some of the marsh areas, as well as cultivated pastures prior to harvest would be included. Mean fuel bed height is 2.5 feet with at least one-third of the fuels dead or cured to provide available fuel to maintain fire spread.

Shrub Group

Model 4 - Chaparral - Fire intensity and fast-spread fires involve the foliage and live and dead fine woody materials in the crowns of a continuous overstory of shrubby vegetation. Mean fuel depth is six feet. Areas of mixed chaparral or chamise-dominated chaparral are examples of this type. Besides foliage, there is considerable standing dead material that contributes to fire intensity. However, the aerial position of the bulk of the fuel complex, as well as the high moisture of its live fraction, creates a fuel system of relatively low ignition potential for fires

originating within the stands. In areas where significant litter has accumulated (e.g. areas with scrub oak) surface fires may occur under conditions that will not support involvement of the shrub crowns. In these instances, the fire will behave more like that predicted by Model 5.

Model 5- Low Brush - Fire is generally carried by the litter and surface fuels of low brush (two feet high), and any grasses and forbs that may be present in the understory of shrub interspaces. Fires in this type are of low to moderate intensity due to relatively low fuel loadings, or low available fuels due to young brush with little dead material. Areas supporting relatively young stands of brush or mature but mesic areas of north coastal scrub would be classified into this model type. Areas of intermediate aged mixed chaparral as well as mature California sagebrush (*Artemesia californica*) may be classifed into the Dormant Brush (Model 6) which generates intermediate fire behavior between Models 4 and 5. Some areas dominated by coyote bush within the watershed follow a gradient based on slope position, with more developed stands lower on the slope (Model 6), gradually lowering in stature as one moves upslope, until reaching the ridge as short brush (Model 5).

Litter Group

Model 8 - Closed Timber Litter - Slow burning surface fires with low flame lengths are the rule in this model type, with isolated jackpots (fuel accumulations) flaring up and possibly initiating crown scorch or low level crowning. Only under severe fire weather do these fuels pose significant fire hazards. Closed canopies of short needle conifers and hardwoods support a densely compacted surface fuel layer composed mostly of leaves, needles and some twigs. Little understory growth is present, and low vertical continuity of fuels linking the overstory is present, minimizing crown fire potential. All the closed canopy hardwood types, as well as some areas dominated by native conifers are classifed into this mode type. In addition, most of the immature conifer plantations would be in this type.

The fuel model scheme and accurate fire behavior prediction in conjunction with other site characteristics such as accessibility, road perimeters, and slope position can be used to delineate fire management zones from which site-specific activities can be designed and scheduled.

Mapping of Fuel Models

Fuels on the Alameda Watershed were surveyed on aerial photographs (conventional color at 1:36,000, color infrared transparencies at 1:24,000-29,000), spot checked in the field, and then related to the Natural Communities map (Figure 2-1). The various Natural Communities (Holland 1986) reflect current vegetation composition of dominant species, as well as variable characterization of the associated plant/fuel structure. Each community type was visited in the field to determine the appropriate fuel model type. Field reconnaissance was conducted after full cure of herbaceous vegetation in early July 1993. These sources of information were used to compile Figure 5-1, Fuel Model/Fuel Hazard Zones of the Alameda Watershed.

It was determined that for the purposes of this phase of planning, the plant community boundaries could be adequately correlated with current fuel models for conducting fire behavior modeling should such analysis be desired later in the planning effort (e.g. site specific planning for fuel manipulation). Although the fuel model map is a derived layer from the vegetation classification, it should be noted that the natural community designations are likely to reflect greater variability in fuel model terms than the fuel hazard index used in the wildfire severity mapping mandated by law. Table 5-1 cross-references the various natural community classifications to the assigned fuel models and fuel hazard ratings.

Each discrete natural community was ground surveyed both for its appropriate vegetation classification as well as its best fit in terms of fuel model. Some areas follow a gradient of successional development that over time changes the characteristics of the fuels from one model to another. At present, some of the vegetation polygons provide a sufficient range of vegetation structure to question that applicability of one single fuel model to present that entire community. However, with limited time and resources available to refine discrete fuel zones, the most applicable model was chosen on the basis of majority of area covered. With additional time and resources, these zones can be further rectified to more accurately represent on-site fuel conditions.

Past activities that may have altered individual fuel complexes may not be reflected in the fuel model classification. For instance, an area dominated by blue oak woodland may be under-burned with prescribed fire to remove some vertical continuity of fuels as well as take out the fine fuels that would drive a wildfire. Although this area may appear to remain within the same fuel model, the treatment alters its fuel characteristics such that a more complete characterization is required. Such a refined modeling approach is currently underway in the East Bay Hills, where a consortium of agencies is cooperatively assessing fire hazard and developing a Vegetation Management Plan. This refined fuel modeling classification includes a successional description within each fuel model so that each increase in the succession index will result in a doubling of flame length (Martin 1993).

TABLE 5-1: ALAMEDA WATERSHED FUEL MODELS

Natural Community	Community Number	Structural Type	Fuel Model	Model Number	Fuel Hazard Rating
Mixed Evergreen Forest	1	tree	Closed timber litter	8	3
Valley Oak Woodland	2	tree	Timber with grass understory	2	3
Blue Oak Woodland	3	tree	Timber with grass understory	2	3
Willow Riparian Forest	4	tree	Closted timber litter	8	3
Live Oak Riparian Forest	5	tree	Closed timber litter	8	3
Alder Riparian Forest	6	tree	Closed timber litter	8	3
Sycamore Woodland	7	tree	Timber with grass understory	2	3
Northern Coastal Scrub	8	shrub	Low brush	5	2
Chamise Chaparral	9	shrub	Chaparral	4	2
Northern Mixed Chaparral	10	shrub	Chaparral	4	2
Valley Bunchgrass Grassland	11	herbaceous	Tall grass	3	1
Serpentine Bunchgrass	12	herbaceous	Short grass	1	1
Non-native Grassland	13	herbaceous	Tall grass	3	1
Freshwater Marsh	14	wetland	n/a	0	1
Cultivated	15	herbaceous	Short grass	1	1
Reservoir	16			0	0
Urban/Bare	17			0	0

SOURCE: REMAR, 1994.

Spatial Distribution of Fuel Models

Although the Alameda Watershed contains significant fire hazards, the distribution of fuel types differs from that found on the Peninsula Water; additionally, corresponding differences in land use and social factors in in eastern Alameda County present a markedly different picture of fire-related considerations. Table 5 -2 gives the acres and percent coverage for each fuel model. Unlike the Peninsula, the Alameda Watershed is dominated by grassland fuel types, with pure

open grassland covering over 20,000 acres, or slightly over 50 percent of the landscape. Spatially, these fuels pervade the landscape throughout the watershed, intermixing with heavier fuel types in the canyons. Since much of the area is grazed, it should be considered in a low development stage during most of the fire season. The net effect of grazing, depending on degree of utilization, is to reduce both rate-of spread and fireline intensity. However, the major arteries of human use, such as Calaveras Rd. to the south, have extensive grass fuel areas where fires could originate. However, unlike the areas on the Peninsula, the heavier fuel types adjacent to these grassy areas are derived from mixed hardwood species, in which fuel structure presents relatively lower hazards than their Eucalyptus/Conifer counterparts.

An additional 8,700 acres (22 percent) are represented by fuel Model 2, in vegetation types where grasses are interspersed by moderate cover of mature oak, such as the blue oak woodlands east of Calaveras Lake and south of Arroyo Hondo. These landscapes intergrade between pure grass stands and denser canopy hardwood forests of oak, bay, madrone, etc. represented by Model 8. There are some additionally worrisome areas of shrub fuels adjacent to grass dominated systems, where fire spread into the shrubby areas would present significantly more dangerous fire behavior.

Only relatively isolated stands of northern coastal scrub types represented as Model 5 are present on the Alameda Watershed, and their physiognomy is somewhat different than on the Peninsula. Much of the 1,450 acres of Model 5 lands are dominated by low stature California sagebrush, which has a somewhat higher ignition potential than Bacharris dominated fuels. Other Model 5 areas intergrade with heavier shrub fuels of chamise and mixed chaparral, creating areas of extreme fire hazard, such as portions of Poverty Ridge.

Isolated areas of hard chaparral, dominated by chamise, and represented as fuel Model 4, are scattered throughout the watershed, totaling an estimated 300 acres. Although these areas are not represented as discrete vegetation polygons, the fire hazard considerations associated with these systems warrant special mention. Although all of the brush fuel complexes are mapped as Model 5, approximately one quarter of that category, or a net of one percent of the watershed are actually better modeled as chapparal. These areas present the highest fire danger on the watershed, due to their relatively high ignition potential and extreme fire behavior. Rates of spread can be expected to be greater than three miles per hour, and flame lengths greater than 30 feet are not unlikely during periods of high fire danger. As mentioned above, portions of Poverty Ridge and Upper San Antonio Creek, have scattered stands of this type. In general, as these stands age, they accumulate both standing dead materials as well as increased surface fuel loads,

indicating that successional development is an important criteria for assessing their actual hazard. With additional resources, comprehensive mapping of these vegetation/fuel types would be desireable.

Much of the canyon areas, particularly on north facing slopes, are dominated by closed canopy hardwood forests of mixed evergreen species such as live oak, madrone, and bay- laurel. These highly stocked areas are modeled as fuel Model 8, and make up about 3,200 acres, or nine percent of the watershed. Although they generally occur on steep terrain, the closed canopy and relatively low flammability and compact structure of the surface fuel-bed dictate low fire hazard. Only very isolated portions of aerial fuels are likely to crown during extreme environmental conditions. An additional 500 acres are represented as Model 8 by riparian forests of alder, willow, and oak. These areas support somewhat greater surface fuels due to more mesic site factors, and areas where significant grass/shrub fuels exist, the fire danger is somewhat higher. It should be noted, however, that with the passage of fire-free time these communities develop increasingly higher woody fuel loads at the surface due to dying trees and branches and shrub development. In some areas of Arroyo Hondo and Alameda Creek, there are isolated areas where fire behavior is expected to be under-estimated due to this successional advancement of the fuel complex.

TABLE 5-2: ALAMEDA WATERSHED FUEL MODEL ACREAGE

Model No.	Fuel Model	Acres	Percent
	Water, Urban, Bare	4,564	11.7
	Marsh	117	0.3
1	Short Grass	1,453	3.7
2	Timber with Grass Understory	8,748	22.3
3	Tall Grass	19,169	49.0
4	Chaparral	300*	0.8
5	Low Brush	1,114	2.8
8	Closed Timber Litter	3,679	9.4
	Total	39,144	

* Estimated acreage

SOURCE: REMAR, 1994.

Fuel Hazard Classification

Classification of the watershed landscape into various fuel models is useful for modeling fire behavior and also provides the basis for assigning fuel hazard ratings used in determining overall fire severity and sensitivity to fire. Table 5-1 lists the fuel hazard rating assigned to each fuel model. The method for deriving the fuel hazard rating and its purpose is described in the following section.

Fire Severity

As mentioned in the introduction to this section, characterization of fire hazard in the Alameda Watershed involved development of two resource maps: a fuel model/fuel hazard zone map and a fire severity zone map. The fuel model/fuel hazard classification system is designed to allow physical modeling of fire behavior in the watershed, while the fire severity mapping is intended to define the areas at greatest risk of severe fires. Those areas which are considered sensitive to a wildfire can be classified into several categories of potential damage. The first category of damage is life and safety of the SFWD personnel and the public in general. The second is damage to improvements such as structures (dwellings both on and off SFWD lands, filter plants, maintenance yards and the water temple), fences, dams and reservoir capacity. The third category of potential damages would be natural resources. Generally, the natural vegetation is resilient to fire's occurrence since it has been a natural and common event shaping the characteristics and distribution of watershed vegetation. However, in unusual circumstances fire can harm natural resources including subsequent effects on water quality. It should be noted that all areas are protected by law from damage from arson fires, but no other obligatory protection currently exists regarding fire-related damage.

The California Wildfire Severity Law (AB337) mandates categorization of values at risk. This law, passed in 1992, requires that each county, including San Mateo, Santa Clara, and Alameda, map very high fire severity lands before January 1, 1995. In those very high fire severity zones, new regulations regarding hazard mitigation, or maintenance for fire safety will be promulgated. The methodology required under the new law can be used to identify where the first two categories of damages (life and property) are likely to be the most extensive. The third category of potential damage (natural resources) is not easily mapped because the extent and severity of damage is determined in part by the size of the fire, season of the burn, edaphic and climatic factors, vegetation and fuel conditions, and last but not least, the burning characteristics of the

fire itself. This wildfire severity classification methodology, explained below, was used to develop Figure 5-2, Wildfire Severity Zones of the Alameda Watershed.

Categorization of Wildfire Severity as Mandated by Law (AB337)

The ratings mandated by the California Wildfire Severity Law are designed to incorporate measures of three criteria into one general fire severity index that can be used to direct fire management activities. The index is based on three criteria: dwelling density, slope steepness, and fuel hazard rating. The index can be slightly altered by considering unusual weather or fire history. Points are attributed to the severity of each of the criteria, and the points are then added to arrive at a total fire severity rating. The fire severity index varies from one to ten, with each of the three components contributing relatively equally. Areas with an index of seven or greater are described as very high severity and, thus, should be a focus of management efforts. Areas with an index of four to seven are a "moderate" fire severity under this categorization scheme. Areas with an index of three or less are "low" fire severity. The ratings are to re-evaluated every five years, taking into account such changes as: (1) management activities to reduce fuels, (2) fires in the area, (3) new development, and (4) succession of vegetation over time (e.g. the transformation of shrublands into forests or woodlands over time). Table 5-3 summarizes the criteria used to rank fire hazard severity as mapped in Figure 5-2.

Steep areas with voluminous biomass that abut a high density of structures would be described under this rating as having a high potential damage. Conversely, areas of grass on flat lands far removed from structures would be rated as having the lowest potential damage. Because the resolution used to apply the fire severity rating is one square mile, the density of structures in the proximity to SFWD lands becomes important even though SFWD lands themselves do not contain many structures. This methodology is appropriate because a fire can easily cross the boundary both onto and away from SFWD property. The weighting of the factors in this ranking system is such that an area with steep slopes and heavy fuels automatically rates a high wildfire severity. Also, the highest scoring is attributed to a density of only one structure in every five acres; thus, almost all residential areas are a focus in this ranking system.

The statewide mapping of very high fire severity is intended to serve several purposes. First, those locales with very high fire severity will be required by law to promulgate regulations designed to reduce fire losses through more fire safe construction and development as well as

TABLE 5-3: FIRE HAZARD SEVERITY CRITIERIA

FUELS CRITERIA	POINTS
Grass, Small Shrubs	1
Brush, Small Trees	2
Timber, Woodland, Large Brush*	3
SLOPE STEEPNESS	
0 to 10%	1
10 to 20%	2
20 to 40%	3
over 40%	4
DWELLING DENSITY	
< 1 unit per 10 acres	1
1 unit per 5-10 acres	2
1 or more units per 5 acres	3

* Includes landscaping.

SOURCE: Wildland Resource Management, 1994

increased vegetation management. Second, the mapping will help educate residents in these very high fire severity areas of the potential for catastrophic losses through wildfire. The ultimate goal of the State for mapping these areas is to reduce losses of property, increase life safety and decrease suppression costs.

Component Criteria

Figure 5-2 is a composite index map of wildfire severity that is useful for identifying areas at risk for serve fires; however, maps of the component criteria (slope, dwelling density and fuels) are also of value. Slope data, derived by geo-processing techniques on the GIS system from an enhanced version of a Digital Elevation Model, was categorized based on the National Fire Protection Association Standard 299 (California Department of Forestry and Fire Protection 1993). The slope map can indicate constraints on various manipulation techniques (i.e. where mechanical treatment is not practical because slopes are too steep). The slope data layer can likewise assist prediction of fire behavior, and in part, fire suppression difficulty. The categorization of fuel hazard derived from the fuel model map indicates where hazardous conditions warrant fire protection/fire management activities. The dwelling density layer,

interpreted from aerial photographs (at 1:36,000) can be used to quickly identify where the concerns for life safety and property damage are paramount. Maps of dwelling density can also be used in non-fire related analyses such as wildlife habitat maintenance, recreational use, and visual impacts of various land use and management options.

Fuel Hazard Classification

This classification system is used to identify fuel characteristics on a coarse resolution suitable for developing fire management policy. In conjunction with slope and structure density indices, the fuel hazard index can be used to: (1) assess overall fire protection problems, and (2) locate areas of most critical concern. Subsequent ideas regarding fuel manipulations can be evaluated on a site-by-site basis, using additional site specific information (e.g. access, fuel models, micro-topography, etc.).

For the purpose of fire severity mapping, the six fuel models described in the previous section can be divided into three categories based on the dominant vegetation structure in increasing order of hazard. Thus, all areas dominated by grasses and other herbaceous vegetation are given an index of 1, areas dominated by brush and other short woody vegetation are given a 2, and areas dominated by trees (which may burn as crown fires) or extremely heavy brush are given a 3 (California Department of Forestry 1993). Table 5-1, above, summarizes the hazard ratings for each fuel model. These fuel indices are generally taken from the National Fire Protection Association Standard 299 and correspond to the natural community classification scheme with the exception of the oak woodlands, which depending on density, can be classified as moderate (2) or heavy (3) fuel hazard. Characteristics of the fuel hazard classes found in the Alameda Watershed are described below:

Low - The low fuel hazard index is comprised of fuel complexes that are dominated by herbaceous plant species (grasses and forbs). Expected fire behavior is characterized as having low to moderate fireline intensity. Rapid rates of spread can occur under certain environmental conditions in this fuel hazard index.

Moderate - Fuel complexes dominated by low stature woody vegetation, commonly associated with various shrub dominated vegetation communities. These types range from the more mesic Northern Coastal Scrub dominated by Coyote bush (*Bacharris pilularis*) to the hard chaparral types dominated by manzanita (*Arctostaphylos sp*) and chamise (*Adenostoma fasciculatum*). Although this classification represents a broad range of fuel structures and characteristics, under severe fire weather, all types will result in moderate to high fireline intensity, with active flaming coming from combustion of both live and dead aerial portions of the fuel complex. Under low to

moderate conditions, fires may be unable to sustain spread in areas where there is no litter to provide continuous surface fuels, and only isolated involvement of crown fuels would be likely.

High - These fuel complexes are dominated by tall woody vegetation (i.e. trees) that under severe fire weather can provide aerial fuels in the canopy. These aerial fuels would result in very high to extreme fireline intensity as well as contribute to large scale perimeter increases due to spotting. Although this classification includes a variety of plant communities that have a corresponding variance in expected fire behavior, all present the potential for devastating crown fire. Low fireline intensities associated with understory surface fires are likely to result during low to moderate fire weather, indicating that these areas present the greatest range in possible fire behavior of any fuel types.

Fire Severity mapping was extended 2,000 feet beyond the boundaries of the watershed planning area in order to complete the classification on a square mile basis.. Since natural community mapping was limited to the planning area, classification of fuel hazard beyond the watershed boundaries was based on aerial interpretation of vegetation structure (grass, shrub, and tree).

It should be noted that the fuel hazard rating does not provide sufficient detail to direct site-specific management tasks because there is too wide a variation within fuel complexes and too coarse a spatial resolution to adequately design fire hazard reduction activities. It does, however, provide a means of cataloguing areas and determining general direction of management activities that can be site-specifically scheduled based on the fuel model classification. This scheme does not provide delineation of fire management units; rather, it describes in basic terms the degree of fire protection and hazard conditions present, from which overall program guidelines for hazard reduction can be directed.

Spatial Distribution of Fire Severity Index Zones

Because fire spread does not consider land ownership boundaries, the areas outside the San Francisco Water Department lands, but within 2,00 feet of the boundary were mapped. The acreage figures reported in the following text details only lands within the SFWD boundaries, however, Figure 5-2 shows the larger mapped area. The following discussion of fire severity distribution also considers the larger coverage, including those lands mapped outside SFWD boundaries.

Low fire severity zones constitute 10,426 acres, or roughly one-quarter of the 39,144 acres in the Alameda watershed. Areas with moderate fire severity encompass 20,494 acres, or roughly one-half of the land inside the San Francisco Water Department boundaries. Those areas with (1) a combination of steep slopes combined with any type of fuel, or (2) heavy fuel types and any type

of slope, or (3) built-up areas with any type of fuel or slope comprise lands classified as high fire severity. These areas cover 5,981 acres, or 15 percent of the SFWD watershed lands. Table 5-4 summarizes the results of fire severity mapping in the Alameda Watershed.

Little development exists inside the watershed. Only 205 acres are classified as built-up inside the Alameda Watershed lands. Instead, the fire severity classification is determined by the combination of slope steepness and fuel type. Steep topography throughout the Alameda Watershed (with the exception of the northern part of Alameda Creek, and parts of the basin surrounding the southern side of Calaveras Reservoir) are rather steep--over 20 percent. On slopes greater than 40 percent steepness, vegetation cover other than grass will result in a high fire severity classification rather than moderate. And, in areas of heavy vegetation (generally consisting of woodlands), any lands with a slope steepness over 20 percent would be classified as high fire severity. As a result, the distribution of the "high" fire severity classification roughly follows the distribution of heavy vegetation (such as scrub, and woodlands). The heavier vegetation is generally located on the north and east-facing slopes.

The areas of high fire severity can be roughly divided into four areas:

- the steep drainages south of San Antontio Reservoir,
- the east-facing slopes above Calaveras Rd.
- the north aspects of Alameda Creek
- the north aspects of Arroyo Hondo Creek and its tributaries.

Large portions of the slopes draining into San Antonio Creek and Williams Gulch are also classified as high fire severity because of the heavy fuels on the steep slopes. The north-facing slopes on the south side of San Antontio Reservoir, the north aspects of Apperson Creek, the upper reaches of Indian Creek (as it straddles the SFWD boundaries in Section 30), the portion of La Costa Creek that is south of SFWD lands in section 29, as well as a wooded strip just north of the SFWD boundary, are all classified as high fire severity. In the Arroyo Hondo basin, two unnamed basins leading north to Oak Ridge are also classified as high fire severity because of the heavier fuels on the steep slopes.

Smaller acreages of high fire severity are found in two other locations: the upper reaches of the slopes draining to Calaveras Creek are classified as high fire severity, as are the north-facing slopes along Niles Canyon.

TABLE 5-4: ALAMEDA WATERSHED FIRE HAZARD SEVERITY RATINGS

		ACRES	% COVER
FUELS CRITERIA			
Light	Grass, Small Shrubs	20,739	53.0
Moderate	Brush, Small Trees	12,427	31.8
Heavy	Timber, Woodland, Large Brush	1,413	3.6
Other		4,565	11.7
SLOPE STEEPNESS			
0 to 10%		5,718	14.6
10 to 20%		7,101	18.1
20 to 40%		12,884	32.9
over 40%		9,444	24.1
Other		3,997	10.2
DWELLING DENSITY			
< 1 unit per 10 acres		----	
1unit per 5-10 acres		----	
1 or more units per 5 acres		205	0.5
FIRE HAZARD RATING			
Low	Index ≤ 3	10,426	26.6
Moderate	Index 4 - 7	20,494	52.4
High	Index > 7	5,981	15.3
Other		2,243	5.7
	TOTAL	39,144	

SOURCE: Wildland Resource Management, 1994

As indicated in Table 5-4, slightly less than one-half of the watershed is covered with light fuels, comprised of grass. Slightly less than one-third of the watershed is covered with heavy fuels, which could be heavy brush or woodlands. And less than four percent is covered with moderate fuels described as light scrub or sparse woodlands.

Slightly more than one-half of the watershed is over 20 percent steepness and almost a quarter of the watershed is over 40 percent steepness. Approximately 18 percent of the area is between 10 and 20 percent steepness, and 14 percent is relatively flat.

The fire severity on lands outside the Alameda watershed boundary is generally consistent with lands inside the boundary. However, to the north of the SFWD lands, development is concentrated in the communities of Sunol and the southern reaches of Pleasanton along Highway

680. In addition, pockets of built-up areas are located to the west along Pirate and Sheridan Creeks, and to the southwest along Calaveras, Felter and Downing Roads. The topography is a mixture of steepness, along the watershed perimeter. The fuels are generally light on the western boundary with heavier fuels on the southeastern portion of the watershed, and grass surrounding the north east portion of the Alameda watershed.

Safety

The greatest concern is injury and loss of life. SFWD resident personnel and daily workers as well as watershed visitors can be at risk from a wildfire. The safety of SFWD personnel is the subject of many safety campaigns and several regulations. Another serious concern is the possible threat to life and safety of the public adjacent to SFWD property resulting from a wildfire starting on or passing through watershed lands. As was the case in the 1991 Tunnel Fire in Oakland, people can perish both in the process of evacuation as well as in attempts to protect their property. Lastly, there is a risk to the firefighting personnel resulting from a fire.

The locations where the greatest threat to safety generally occurs are in areas of dense population with poor access (narrow, windy and steep roads serving large numbers of people). Such areas do not occur within the watershed, but likely exist near the boundary. Because relatively few high-grade roads exist in the watershed and a situation could occur in which a fast-moving fire could trap staff and/or firefighting personnel.

Developments, Improvements and Property

The Alameda Watershed contains many improvements of considerable value that could be damaged by wildfire. Not only does the watershed have historic properties such the Sunol Water Temple, it also contains residential cottages and the Sunol Filter Plant which are vulnerable to fire. Additionally facilities such as surface distribution lines, above-ground reservoirs, old flumes, fences, communication stations, and roads would also be damaged by a wildfire. Improvements on properties adjacent to the watershed at risk from wildfire are generally dwellings with associated automobiles, telephone and power poles, and personal possessions.

The most sensitive areas are in residential areas of high fuel loads, those areas which lack clearance around structures, areas of steep slopes, and areas of poor access. In these situations there are few places that exist for firefighting personnel to make a stand. Additionally, fire behavior is expected to be erratic and difficult to suppress in these circumstances.

Natural Resources

A vital natural resource in the Alameda Watershed is the water that runs off the slopes into the reservoirs below. While not directly damaged during a wildfire, water quality and water quantity are unquestionably altered by a large wildfire. Increased sedimentation is the leading cause of water quality degradation associated with a wildfire. Sedimentation is an added detriment by diminishing the capacity of the reservoir. Such damage is related in part to both the extent of the fire as well as the location in relation to the reservoir. Fires which burn most of the slopes surrounding a reservoir or, to a lesser extent, fires which are located directly upstream of a reservoir without a buffer, have the most direct effect on water quality.

Efforts to suppress a fire can also result in damage to water quality and cause increased sedimentation. Areas scraped bare by bulldozers to form control lines can cause significant erosion. Suppression efforts can also damage vegetation. Special status plant species are particularly vulnerable to this type of damage.

There are few circumstances where vegetation itself is sensitive to fire. Fires of all intensities, sizes, seasons, and frequencies have burned throughout the millennia. However, the distribution and characteristics of fires have been recently altered so that more fires are high intensity and large. Today, few low intensity fires burn in California and this is particularly true on the protected watershed lands. For example, in oak stands, fires of low intensity were frequent before settlement time but disturbance has been minimal since the turn of the century (or longer) and a significant understory has developed. Now, a fire in this type of oak stand would harm the older trees and many would die. A portion of the oak trees could be expected to resprout from the base of the tree, but some would not recover.

Rare and endangered species commonly require fire to either initiate germination or alter the micro-habitat to allow growth (i.e. remove thatch or shading plants). Some species may be sensitive to the lack of fire occurrence and because the duration of seed viability is unknown, experimental burns may be desirable. In other locations where rare and endangered species occur, a wildfire may set the stage for invasion by alien weeds which could out-compete the native sensitive species. The response by the site is determined in part by the season of the burn, the fire behavior itself, and the proximity to alien seed sources.

Rarely, two fires will burn so close in time that the species which require seed for propagation are harmed. The species may not have had enough time to reach seeding maturity and thus new

TABLE 5-5: HISTORIC FIRES IN THE ALAMEDA WATERSHED

Fire No.	Year of Fire	Approx Acres	Comments
1	1993	1	house fire
2	1993	40	
3	1991	10	
4	1991	10	
5	1991	10	
6	1991	10	
7	1991	10	
8	1991	10	
9	1990	40	
10	1990	30	approximate date
11	1987	30	approximate date
12	1986	30	
13	1984	30	
14	1984	30	
15	1983	20	
16	1983	30	approximate date
17	1980	100	
18	1080	100	
19	1980	30	approximate date
20	1975	200	approximate date
21	1973	200	
22	1969	400	
23	1964	250	
24	1993	1	
25	1992	1	
26	1991	1	
27	1990	1	
28	1989	1	
29	1988	1	
30	unkown	10	
31	unkown	10	
32	unkown	10	
33	unkown	10	

SOURCE: Wildland Resource Management, 1994.

occurred within the 30 year span of this fire history. This fire occurred in 1984 in the southern portion of this watershed. The rest of the fires were human-caused.

REGULATORY FRAMEWORK

Public Resources Codes 4290 AND 4291

Both watersheds are protected by the California Department of Forestry and Fire Protection (CDF) and, therefore, must comply with State Public Resource Code (PRC) 4290 and 4291, which requires vegetation management along structures and roadsides. All flammable vegetation must be cleared for 30 feet around a structure, and roofs must be maintained free of dead vegetative material. Limbs overhanging roofs must be trimmed of dead material, and branches must be trimmed within 10 feet of chimneys, which must have a screen. Vegetation which is ignited easily (primarily grass) must be removed for a distance of 10 feet from each side of the road. While not a requirement, CDF encourages thinning of native vegetation and all dead material for an unspecified distance on both sides of roads. PRC 4290 requires posting an address at each driveway entrance and specifies standards for sign size and style. PRC 4290 also includes specifications for any new installations of water supply and storage systems, hydrant/fire valves, and road design and signage.

Legal Issues

Because wildland fires have recently become a cause of litigation, the management of the watershed will be influenced by the issue of liability. Where fires start or pass through a parcel of land and cause damage elsewhere, it is not unusual for the landowner to be sued. The most common claim has been negligence, where the landowner knew of a hazard but through an oversight did not mitigate against the hazard. Thus, if significant damage from a wildfire is a possibility, landowners have often taken action to protect themselves from potential lawsuits.

Air Quality Regulations

The Alameda Watershed is part of the Bay Area Air Quality Management District (BAAQMD) which regulates air quality and SFWD must comply with Regulation 5 - Open Burning. The regulation restricts burning for hazard reduction to those times declared as "burn days" by the BAAQMD, or when waivers are granted. Burning for training purposes are exempted from the regulations. Burning must be necessary, which requires the use of an alternative method of fuel removal if feasible.

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6.0 CULTURAL RESOURCES

REGIONAL OVERVIEW

Archaeological evidence suggests that the Alameda Watershed region was a favorable locale for permanent as well as seasonal habitation from prehistoric times up to the ethnohistoric period (circa A.D. 1769). The large terraces and benches that overlook the Arroya de Laguna, and the numerous creeks in Sunol Valley and Alameda Creek, are all excellent locations for prehistoric and ethnohistoric site locations. Some resources are already known to exist on watershed lands, despite the fact that most of the terrain has never been the subject of an intensive archaeological survey. More remote areas such as the upper La Costa Valley, in the vicinity of San Antonio and Indian Creeks, offer good locations for archaeological resources. The upper Calaveras Valley, at the south end of the watershed, could contain additional resources as well.

Preliminary historical review for the Alameda watershed suggests that the major historical periods include the Spanish Exploration/Mission, Mexican Rancho, American and Spring Valley/San Francisco Water Department eras. Numerous historic archaeological sites and historical features and structures associated with most of these periods are now located throughout the Alameda Watershed area. Included are Rancho-era adobe sites and late 1800/early 1900 American homestead and schoolhouse sites, structures and features. Historical resources relating to the development of Alameda water sources consist of wells, reservoirs, dams and tunnels as well as a cottage and barn site.

RESOURCES DESCRIPTION

Prehistory

East Bay prehistoric archaeology has been dominated by the study of large bayshore-oriented shellmounds located in both Contra Costa and Alameda Counties, to the northwest and west of the Alameda Watershed lands. The overall East Bay region was an excellent setting for early and long-term prehistoric settlement. The diversified environment included bay marshlands, oak savannahs and mixed evergreen woodlands, with the various biotic communities providing an abundance of animal and plant resources. Early prehistoric populations found the East Bay ecotones particularly attractive and, as a result, a large and significant archaeological record has been established.

The first intensive archaeological survey of the East Bay region was conducted between 1906 and

1907 by University of California archaeologist N. C. Nelson, who documented some of the most important archaeological sites in central California. The bayshore of Alameda and Contra Costa Counties contained more than one hundred shellmounds and the study of Bay region prehistory began there with Nelson's investigations. Early discoveries at three of the bayshore sites -- Emeryville (CA-Ala- 309), Ellis Landing (CA-CCo-295) and Fernandez (CA-CCo-259) -- provided the basis for the first model of prehistoric cultural succession in the Bay Area. Three stages of development or "horizons" were identified based on site stratigraphy and cultural traits: Early Horizon, circa 2500 B.C. to 1500/1000 B.C.; Middle Horizon, circa 1500 B.C. to A.D. 500; and Late Horizon, circa A.D. 500 to 1769 (Moratto 1984:184, 227).

Equally important was the West Berkeley Site (CA-Ala-307), which provided the "first clear-cut evidence of Early Horizon occupation" in the San Francisco Bay Area; it was concluded that the site was settled as early as 3500 to 4000 years ago and abandoned during the Middle Horizon (Wallace and Lathrap 1975:57-59). A recent archaeological recovery program of disturbed midden and artifacts conducted in association with sewer rehabilitation projects resulted in the recovery of diagnostic shell artifacts that supported the W. J. Wallace and D. W. Lathrap (1975) chronology for CA-Ala-307 (Chavez 1989).

West of the Alameda Watershed lands is an important cluster of sites in the Newark area. Three sites, CA-Ala-328 (Patterson Site), -13 and -12, that are now protected within the Coyote Hills Regional Park, were intensively excavated over several decades by various archaeologists from San Francisco State University, Hayward State University, San Jose State University, Stanford University and the University of California at Berkeley.

Analysis of radiocarbon dates and artifacts led P. Bickel (1981) to conclude that CA-Ala-12 and -328 were first occupied more than 2300 years ago; CA-Ala-13 was settled much later, circa A.D. 300 and was apparently occupied intermittently for at least a millennium thereafter. CA- Ala-328 realized a period of abandonment between circa A.D. 300 and 1500, but was reoccupied during the last few centuries of the prehistoric era (Moratto 1984:255).

Bickel's investigations led to a clear delineation of changes in artifact types and mortuary practices at the three Coyote Hills Sites. Parallel changes from schist to sandstone charmstones and from obsidian of trans- Sierran-origin to North Coast Range obsidian, suggested changes in trade relations over time. Fundamental economic practices appear to have changed very little; also there is no indication of social and cultural replacement at any time, even though individual sites were abandoned for periods of time. These Newark-area sites appear to have been

continually occupied by pre-Costanoan and Costanoan peoples over a span of more than 2000 years.

East Bay archaeological research has been concentrated on the Bay shellmounds, with little attention given to the interior valleys that characterize the Alameda Watershed lands. The Santa Rita Village Site (CA-Ala-413) in Pleasanton is one of the few sites that has been extensively researched in the watershed region. Excavations resulted in the documentation of a wide variety of artifacts, paleo-environmental data and sixty-four prehistoric burials. Two cultural components were identified, both representative of the Middle Horizon; the earlier dating from perhaps 400 B.C. and the later from circa A.D. 100. The later component appears to be a local expression of the "Meganos Aspect," which represents a Middle Horizon intrusion of cultural traits from the Delta area.

Technically outside the Alameda Watershed lands, but within the Alameda Creek riparian corridor, is the Sunol Regional Wilderness Area Site, CA- Ala-428H. The site consists of a midden deposit with associated bedrock mortars. Recent excavations yielded radiocarbon and obsidian hydration dates of 343 B.C. to A.D. 1730 for site occupation, which suggests a Middle to Late Horizon occupation (Leventhal et al. 1989).

Recent survey and test excavation work in the vicinity of the Sunol Water Temple has revealed a prehistoric cultural deposit, which appears to represent a Late Period site (Luby 1992). Details regarding the site are not yet available as further documentation of this yet-to-be recorded resource is in progress.

Numerous other prehistoric cultural sites are documented in the Alameda Watershed region; however, few known sites are located on the watershed lands. The setting is certainly a favorable locale for such resources, with large terraces and benches that overlook the numerous Sunol Valley Creeks, Alameda Creek, Arroyo de Laguna and San Antonio and Indian Creeks in the upper La Costa Valley. The fact that most of the watershed lands have never been the subject of intensive archaeological inspection is probably the reason why more sites are not recorded.

Ethnography and Ethnohistory

At the time of historical contact (circa 1769 A.D.), the general region of the Alameda Watershed lands was occupied by the Ohlone, an indigenous population known to the Spanish as "Costanos" or "coast people." Anthropological argot terms Costanoan a linguistic family consisting of eight

times, while Alisal or Chumison, south of Pleasanton, can trace its history to the late 1800s (Galvin and Galvin 1993). Eventually, however, the population of these villages dwindled as the young adults moved away, the elders died and the land was acquired by non-native people. By 1935 the Costanoan language was all but extinct and by 1968 less than 200 people could claim probable Costanoan/Ohlone descent (Levy 1978:487).

History

Spanish Period (1769-1822) - In the summer of 1769 the Visitador General of New Spain ordered Gasper de Portola to lead an expedition up the coast from San Diego, in search of the Bay of Monterey described by seafarer Sebastian Vizcaino in 1602. Portola and his men, including Fray Juan Crespi and Jose Francisco de Ortega, marched passed Monterey Bay without recognizing the inlet and continued up the coast, entering the San Francisco Peninsula via San Padro Valley in present-day Pacifica. On November 3 one of Portola's hunting parties sited the Bay of San Francisco from a ridge in San Mateo County (Beck and Haase 1988:17; Hoover et al. 1990:214).

Almost immediately Portola sent out troops to explore the newly discovered bay. Under the leadership of Ortega the soldiers marched southward, along the western side of the Bay. On November 6 they became the first Spaniards to enter present-day Santa Clara County and, a few days later, Alameda County. Setting up camp in Palo Alto, under a tall redwood tree,

> Ortega went up the eastern shore of the Bay, and it is thought that he explored as far as Alameda Creek, near Niles. On the return journey to Monterey, Portola's party retraced its former trail through San Mateo, Santa Cruz and Monterey counties (Hoover et al. 1990:398).

In 1770 and 1772 Pedro Fages led exploration expeditions over the first Spanish inland route, partly in search of appropriate sites for Franciscan missions. Beginning in Monterey, Fages and his men traveled northward through the Santa Clara Valley and along the eastern shore of San Francisco Bay. Passing through the current cities of Albany and eastern Richmond as well as along San Pablo Bay to the Carquinez Straits, the soldiers turned east and continued to Antioch. After reconnoitering for a few days, Fages and his men swung southward and on "April 2 they descended Arroyo de la Laguna, crossing it near Sunol. Leaving Sunol Valley they crossed Alameda Creek (and) ascended Mission Pass" (Highway 680) intersecting their outward trail and returning to Monterey (Beck and Haase 1988:17; Hoover et al. 1990:5, 398).

On March 23, 1776, six days after establishing the sites for a presidio and the Mission Dolores at the north end of the San Francisco Peninsula, Juan Bautista de Anza and his party marched to the south end of the Bay, picked up Fages earlier trail and headed north. After reaching Antioch on April 4, the soldiers turned southeast, passing through present-day Oakley, Byron and Bethany before tramping back to Monterey along the eastern Alameda and Santa Clara County borders (Hoover et al. 1990:6, 333).

Late-eighteenth/early-nineteenth-century Spanish expeditions as well as grazing mission livestock may well have traversed the boundaries of the Alameda Watershed lands. Explorers, such as Fages, and soldiers, who drove native people from their villages into the mission system in order to be "converted" and join the labor force, followed trails that led through Mission Pass into the Sunol area. In addition, Indian and Mexican vaqueros herded thousands of head of mission cattle, horses and sheep through the pass to graze in the pasturelands of the Livermore and Sunol valleys (Ambro 1992:114).

> Indian vaqueros and servants were common on the ranchos of pre-Gold Rush California. These partly acculturated, former mission neophytes had acquired their skills in livestock care and horsemanship from their association with the missions. After secularization, those that attached themselves to ranches frequently lived nearby in rancherias with their families (Ambro 1992:8-9).

<u>Mexican Period, (1822-1848)</u> - Throughout the Spanish era the land of Alta California remained under sovereign domain; it was not until the Mexican period that the government systematically began granting large parcels of land to individuals who, to a great extent, engaged in the cattle and tallow trade. Approximately sixty-five such land grants were issued in Alameda and Santa Clara Counties including the 48,436-acre *Rancho el Valle de San Jose* (Beck and Haase 1988:30). The northern section of the Alameda Watershed lands (just above Haynes Gulch) is situated in the southern portion of this Alameda County rancho.

In 1839 Governor Juan Alvarado granted Rancho el Valle de San Jose to four members of the Bernal family -- Agostin Bernal, Juan Pablo Bernal, Antonio Maria Pico and his wife Maria Pilar Bernal, and Antonio Maria Sunol and his wife Maria Dolores Bernal (Hagemann 1965:1; Stuart and Stuart 1966:64-65).

Agostin Bernal's adobe, which was constructed in 1850 on present-day Foothill Road south of Bernal Avenue, is located one-quarter mile west of the watershed boundary. Juan Pablo Bernal

built his adobe in the northern portion of the rancho, on the north bank of Arroyo Valle near present-day Santa Rita Road. The site of this 1852 adobe, which is no longer standing, is two-thirds of a mile northeast of the watershed lands. The Picos, who never resided or constructed any structures on their property, later sold their share of the rancho to Antonio Sunol (Stuart and Stuart 1966:65-66; CIHR 1976:125). The Alameda Watershed lands are situated in the Sunol portion of Rancho el Valle.

Antonio Sunol, born in Spain and educated in France, arrived in California around 1817 and soon thereafter settled in San Jose. In the pueblo he acted as postmaster in both 1826 and 1829, served as Sindico from 1839 to 1840, was a member of the Junta in 1843 and between 1841 and 1844 functioned as subprefect (Stuart and Stuart 1966:66; Ambro 1992:8).

Although Sunol never lived on the rancho, his son, also named Antonio, evidently took up residence on the land, caring for his father's 10,000 cattle, 500 horses and 5,000 sheep. By the 1840s the Sunol homeplace, which was located in the vicinity of the present-day Water Temple, consisted of an adobe on the banks of Alameda Creek, an adobe blacksmith shop and, in all probability several storehouses, animal corrals, a slaughterhouse and other outbuildings as well as vegetable gardens, orchards and grain fields (Hendry and Bowman 1940:637-638; Ambro 1992:8).

Except for the Ohlone villages of El Molino and Alisal/Chumison as well as the rancho-era Sunol Adobe and surrounding outbuildings, no potential historical archaeological remains or features associated with the Spanish or Mexican periods are known to have existed within or immediately adjacent to the Alameda Watershed lands.

American Period (1848-present) - After the signing of the Treaty of Guadalupe-Hidalgo in 1848, California became part of the United States, and under the 1851 Gwin Act, a commission was established to settle disputes arising over the validity of Mexican land grants. Because many of the claims were poorly recorded and because of pressure from landless American squatters, by 1871 the court had heard over 800 cases involving 500 land grants and rejected claims totaling two-and-a-half-million acres. Although the Land Commission confirmed Rancho el Valle de San Jose ownership to the Bernal family on January 31, 1854 and patented the claim of 48,436 acres to Antonio Sunol, Agostin Bernal and Juan Bernal on March 15, 1865 (Hagemann 1965:2, 9; Hynding 1984:50), the Bernals and Sunols were plagued by an onslaught of settlers following the 1849 Gold Rush.

As a result, during the early American period, portions of Rancho el Valle de San Jose were either sold or leased to settlers or simply expropriated by people who squatted and grazed their cattle on the land; in 1855 Sunol's son, Antonio, was killed by a squatter somewhere between his home and Mission San Jose. Although Sunol sold most of his holdings to his brother-in-law, Juan Bernal, in late 1849, he retained the land encompassing the homeplace, south and southeast of present-day Sunol (Ambro 1992:9-10). Even so, "the land held by the original Spanish family...dwindled considerably, many selling...for any price they could get" in order to pay high taxes, interest on loans and legal costs in an effort to keep their property. By the late-1870s much of the rancho land within the Alameda Watershed had passed into the hands of other parties (Hagemann 1965:2).

These other parties included such people as Charles Hadsell, who rented several hundred acres from the Sunols beginning in 1856 and by 1865 had purchased over 1,300 acres of their land. Just north of Hadsell's property, George Foscalini established a store around 1860 and in 1862 Frenchman Monsieur Bertrant opened the Argenti Hotel nearby. A few years later Thomas Scott purchased both the hotel and store and the area became known as Scott's Corner (Baker 1914:446; Ambro 1992:10-11).

Sunol family members, however, as well as other Hispanic people who may have been relations, retained much of the rancho land within the watershed. Pedro de Saissett, who had married the younger Antonio Sunol's widow, owned 3,251 acres south of Hadsell's property and to the northeast, along the north and south forks of San Antonio Creek, Dol A. Sunol (460 acres), N. M. Sunol (453 acres), J. Sunol (398 acres) and Juan F. Lacoste (2,952 acres) also owned land. All except Lacoste held their property until the turn of the century (Thompson and West 1878; Nusbaumer and Boardman 1900; Ambro 1992:11-12).

By 1869 the Central Pacific Railroad (and later the Southern Pacific) was constructed through Niles Canyon, creating and developing the towns of Pleasanton, Livermore and Sunol (Wood 1883:460). With the establishment of Sunol Station, the former Rancho el Valle de San Jose lands became more accessible to settlement and to farmers who needed to ship their agricultural products to market. Although the area around and north of Sunol began to develop, the land to the south, within the northern part of the Alameda watershed, remained fairly rural and open (Thompson and West 1878).

By at least 1878 several more Anglo settlers had obtained former rancho land within the watershed. They included Charles Duerr and L. Nusbaumer (approximately 700 acres), M.

Rogan (approximately 250 acres), C. Murphy (110 acres), Mrs. O'Neil (approximately 100 acres) and B. F. Lee (137 acres). Individuals also owned property outside the rancho boundaries, in the northeast arm of the northern portion of the watershed, east of upper Indian and La Costa Creeks. These settlers included Augustus D. Splivalo (313 acres), D. Splivalo (150 acres), L. Dotta (223 acres), J. Argent, (152 acres) and Charles McLaughlin (1,707 acres) (Thompson and West 1878). McLaughlin, who worked for the Western Pacific, was paid in "railroad land" rather than money and, as a result, acquired nearly every other section of public lands in many of the mountain ranges throughout the East Bay (Loomis 1986:36).

The northwest arm of the northern portion of the watershed was also outside the boundaries of Rancho el Valle de San Jose, although some lay within the former Mission lands. The people who owned property in this area by 1878 included M. A. Blake (150 acres), J. Antonio (222 acres), Mrs. J. Healy (191 acres), Charles Hadsell (198 acres), J. Kose (40 acres) and the Spring Valley Water Company (approximately 350 acres) (Thompson and West 1878).

Although some parcels changed hands over the years, they remained in private ownership. The exception was Hadsell's approximately 1,300 acres, which encompassed the present-day San Francisco Water Department Alameda Headquarters. By 1900 this land had been purchased by Spring Valley Water. Evidently from that time on, the water company aggressively sought to buy out every farmer and rancher in the area; by 1907 Spring Valley Water had acquired over 80 percent of the present northern Alameda Watershed lands and by 1915 had added several more parcels (Nusbaumer and Boardman 1900: Haviland and Prather 1907).

<u>Spring Valley Water Company Period (1870-1930)</u> - By 1874 much of the public land throughout the country was being plotted by the United States Geological Survey and divided into 640-acre sections. The open, public land outside the Rancho el Valle de San Jose, south of Haynes Gulch, which was partitioned into odd-shaped, privately- owned parcels or was still open range, was also subject to the United States Geological Survey. Although there is little visible evidence of the farms and homesteads that once occupied the southern part of the Alameda Watershed, by 1876 most of the surveyed sections, half-sections, quarter-sections and earlier, odd-shaped parcels were occupied by ranchers or farmers who grazed cattle as well as planted fields of grain, vineyards, orchards and vegetable gardens (Thompson and West 1878:24-25, 28).

The homesteaders located along Alameda Creek in southern Alameda County by 1878 included J. F. Brannon, O. C. Miller and William Waddell (all with 480 acres), J. F. Keene (320 acres), P. Nolan (200 acres), E. Kochles (188 acres) F. Castello, J. S. Dwartz, L. Geary, the Hollenbecks, J.

A. Moultrio and A. Oleson (all with 160 acres), F. Kell, J. Madal and F. Pincle (all with 80 acres) and F. Joseph (40 acres). In addition, Charles McLaughlin owned over 2,000 acres, while Spring Valley Water Company had acquired nearly 1,500 acres bordering Alameda and Calaveras Creeks (Thompson and West 1878).

By 1876 the farmlands located on the Alameda watershed of northern Santa Clara County, east and west of Calaveras Creek, were held by Thomas Sox (739 acres), John Sherman (417 acres), H. G. Bultey (335 acres), John Carrick & the Williams Brothers (320 acres), Joseph Weller (280 acres), L. H. Hayden (240 acres), Alexander Anderson, Mrs. Fredrick Brandt, John Carrick, T. A. Cunningham, J. McDonald, P. O'Brien and John Patton (all with about 160 acres), J. D. Greenfield (150 acres), B. F. Beebe and E. White (both with 120 acres) and J. Alter, D. Cullen, D. Dyer, P. Murray and David & Thomas Williams (all with about 80 acres), while Charles McLaughlin owned 120 acres (Thompson and West 1876:25).

In addition, approximately 1,800 acres along the banks of Calaveras Creek had been acquired by Spring Valley Water Company. This property encompassed Nick Harris' 200 acres planted in clover, Hiram Pomeroy's 170 acres covered with grain fields, vineyards and orchards and Dudley Wells' 200 acres of wheat and potatoes -- all of which were owned by the water company by 1874. Over the next two years the rest of the creekside farmers sold to Spring Valley Water including David Campbell who had 200 acres in wheat, barley and flax and W. S. Gaines who grew wheat and alfalfa on his 200 acre parcel (Loomis 1986:26-28).

As the Calaveras Valley filled with family farms, people moved farther into the mountains to the east,

> back into the unfenced, trailless wilderness that stretched all the way to the San Joaquin Valley. This was country slashed by rocky canyon and crowned by pine-fringed mountain peaks, where rare giant manzanita grew beside ancient oaks, where madrone and laurel-shaded springs fed year-round streams. This was cattle country and every other section (640 acres) was government land waiting to be homesteaded (Loomis 1986:35-36).

Within the southeast portion of the Alameda Watershed, along and north of Arroyo Hondo, nearly 3,000 acres remained vacant by 1876, while both north and south of the arroyo the ubiquitous Charles McLaughlin owned approximately 2,800 acres (Thompson and West 1876:28). In the Poverty Ridge area, south of Arroyo Hondo, were the ranchlands of David and Thomas Williams, who possessed 800 acres, and, in conjunction with John Carrick, an additional

As the waters of the Calaveras Reservoir began to spread they

> covered the foundation of homes of the early settlers and climbed up the stumps of fruit and shade trees that marked the farms of families named Sherman, Wells, Campbell and Pomperoy. Most of the barns and houses and other buildings had been torn down and the lumber hauled away by neighbors, and the trees had been cut down for firewood before the lake began filling up. The lake wiped out the road which ran the length of the little valley and necessitated construction of the higher road that dodges in and out of the little canyons along the west sides of Calaveras Lake (Loomis 1986:69). Calaveras (Reservoir) has a watershed area of...139.48 square miles, of which 16.79 square miles are in Alameda County and 127.69 square miles in Santa Clara County (Hanson 1985:16).
>
> The Calaveras supply was discharged from the reservoir through a 48-inch pipe laid in an outlet tunnel which pierced the west abutment of the dam. The water was allowed to flow down Calaveras Creek to Sunol, where it percolated through the gravels into the infiltration system (at the Water Temple).
>
> The well supply from the Livermore Valley was abstracted from the underground gravels by pumps and discharged into a 30- inch pipe, 28,000 feet long, which carried it to Sunol and delivered it into the main gallery of the infiltration system at the Water Temple,...the meeting-point of the various sub- sources of the Alameda system (Elliott 1926:4, paraphrased).

From the Temple the water was carried through an underground concrete conduit to Sunol Dam and then conveyed via the Sunol Aqueduct down Niles Canyon to Niles Dam. During the construction of the Calaveras Dam, a new Sunol Aqueduct was built.

> Formerly the aqueduct, which is five miles long, consisted in equal parts of concrete-lined tunnels large enough to carry seventy million gallons of water daily and a wood flume which could transport about thirty million gallons of water per day. During the summer of 1923 the wood flume was replaced (Elliott 1925:5). The new aqueduct, built of reinforced concrete, had twice the capacity of the wood conduit. The entire aqueduct from Sunol to Niles is now built entirely of concrete (Elliott 1924:5). The Alameda Diversion Tunnel and Dam were also under construction during the building of the Calaveras Dam. Completed in the mid-1920s, the dam helped channel the water from the 40-square-mile, Upper Alameda Creek run-off into the 9,700-foot-long tunnel, which emptied into the Calaveras Reservoir (Elliott 1926:3).

By the turn of the century, San Francisco had adopted a new city charter that allowed its citizens to establish a municipally-owned water system.

> In 1910, San Francisco voters had approved $45 million in bonds to finance a mammoth Sierra water project which would turn the beautiful Hetch Hetchy

> Valley of Yosemite National Park into a giant reservoir. The plan was to build a high dam to impound the Tuolumne River at the entrance to the valley. The water would then be piped 150 miles by a gravity feed across the Central Valley, through a 25-mile tunnel in the Coast Range, and under the bay into the Crystal Springs Reservoir. By 1924 the dam was completed (Hynding 1984:264- 265).

Three years after the Hetch Hetchy Dam was finished, construction began on the 29-mile-long Coast Range Tunnel, approximately seven miles of which cross the Alameda Watershed lands.

> Never before had such a long tunnel been proposed through such difficult ground. The coast ranges of California are geologically unstable, made of weak sedimentary rocks and fractured with innumerable faults. The hazardous working conditions quickly proved to be even worse than predicted, as miners encountered explosive gases, ground water under great pressure, quicksand and swelling ground. Eventually, all problems were solved, and the Coast Range Tunnel was "holed through" on January 5, 1934. First delivery of long-awaited Hetch Hetchy water to the city came late that year (Myers 1977:23-24).

After the properties and facilities of the Spring Valley Water Company were transferred to San Francisco officials on March 3, 1930, a publicly-owned, non-profit utility company -- the San Francisco Water Department -- was organized (Cherny and Issel 1981:49). Over the last few decades many changes in operational procedures as well as water storage and conveyance have taken place within the Alameda Watershed. Since 1949 the water from the Pleasanton wells has not been exported from Livermore Valley but has been used instead for local purposes. In addition, the water from Calaveras Reservoir no longer flows via the Water Temple and the Sunol Aqueduct; today, along with the water from San Antonio Reservoir (completed 1965), it is conveyed through the Sunol Valley Filtration Plant (completed 1966) and directly into the Hetch Hetchy Aqueduct (Milstein n.d.; SFWD n.d.; Hanson 1985:17, 19).

Presently the San Francisco Water Department leases much of its property to cattle ranchers, nursery owners, quarry operators and golf course managers. Although the Alameda Watershed lands are not currently open to the public, the Sunol Water Temple remains accessible to visitors and the beauty of this structure continues to attract thousands of sightseers from around California, the nation and the world.

Known Cultural Resources

Archival research and field review for the Alameda watershed has produced a listing of seventy-one archaeological and pre-1946 historical resources located within the study area boundaries. Figure 6-1, Cultural Resources of The Alameda Watershed, shows zones of potential cultural resource sensitivity as well as known cultural resources organized into five major categories described below. Each of the known cultural resources is represented on the the map by a number and category symbol that corresponds to the detailed listing presented at the end of this section in the List of Known Cultural Resources. Also identified on the map are archaeologically sensitive areas, where additional prehistoric and historic archaeological resources may be located. Sensitive areas include valleys where water sources are present and relatively flat terrain where creeks and springs provided potable water. Ridgetops are included where prehistoric trails and temporary encampments, as well as historic features and site, may be situated.

Cultural Resources Categories

- No *National Register of Historic Places* resources are presently listed or determined eligible for listing. However, several prehistoric, ethnohistoric and historic resources have good potential for eligibility.
- *Historic structures and features* include pre-1946 Water Department wells, reservoirs, dams, tunnels and facilities buildings as well as a cottage, bridge, fountain, adit tower, barn, mine shaft and the Sunol Water Temple complex.
- *Historic archaeological resources* include three rancho-era adobes, thirty-four homesteads sites, five school sites, the Brightside cottage site and the Coast Range Tunnel labor camp.
- *Prehistoric archaeological resources* include two midden sites, neither of which has been formally recorded; one of which remains unconfirmed.
- *Prehistoric/ethnohistoric resources* include two locations identified by Native Americans Phillip and Andrew Galvan; neither site has been officially recorded.

Table 6-1, Known Cultural Resources of the Alameda Watershed, summarizes the known resources giving approximate date, register status and relative sensitivity based on status and condition.

TABLE 6-1: KNOWN CULTURAL RESOURCES OF THE ALAMEDA WATERSHED

NUMBER	TYPE*	NAME	DATE	STATUS**	COMMENT	SENSITIVITY
1	Hist. Struct.	Four wells; "O" Line				Low
2	Hist. Struct.	Five wells; "F" Line				Low
3	Hist. Struct.	Five wells; A Line				Low
4	Hist. Struct.	Homestead-era House	circa 1906		one two-story house	Moderate
5	Hist. Struct.	Castlewood Reservoir/Chlorination Building				Moderate
6	Prehist/Ethn	Prehistoric and Ethnohistoric village, Alisal (elder trees) or Chumison (Native American name)	abandoned ca. 1900		100-person roundhouse	High
7	Hist. Struct.	Brightside Chlorination Building/Tanks/Meter Gate and Weir	1901, 1901-1902			Moderate
8	Hist. Arch.	Brightside Cottage Site	1907		privy & watertank were also present	High
9	Hist. Arch.	Homestead-era Site	circa 1906		one structure	High
10	Hist. Struct.	Sunol Dam	1900			Moderate
11	Hist. Struct.	Chlorination Building	circa 1906			Moderate
12	Hist. Arch.	Old House Site			foundation only	Moderate
13	Prehist/Ethn	Prehistoric and Ethnohistoric Village, El Molino.	abandoned mid-1800		milling site during Spanish-Mission era	High
14	Hist. Struct.	Sunol Water Temple	1900-1910	3, 4	complex includes forebays, filtergalleries and a concrete fountain type feature	High
15	Prehist. Arch.	Prehistoric Archaeological Site			no site record or number	High
16	Hist. Arch.	Adobe House Site	1850s		estimated location	High
17.1	Hist. Arch.	Antonio Sunol Adobe Site	1840s			High
17.2	Hist. Arch.	Charles Hadsell Homestead Site	1862			High
17.3	Hist. Struct.	San Francisco Water Department's Headquarters	circa 1900, 1930			Low
17.4	Hist. Arch.	Suspension Footbridge Footings Site	1910			Low
18	Hist. Arch.	Adobe Blacksmith Shop Site	late 1840s/early 1850s			High
19	Hist. Arch.	Sunol School Site	circa 1900			High
20	Hist. Arch.	Vallecitos School Site	circa 1878			High
21	Hist. Struct.	Mendoza Barn				Low
22	Hist. Arch.	Homestead-era Site	late 1800s			High
23	Hist. Arch.	Sullivan Homestead Site	late 1800s			High
24	Hist. Arch.	Homestead-era Site	late 1800s			High
25	Hist. Arch.	La Costa School Site	circa 1900			High
26	Hist. Arch.	Homestead-era Site	circa 1906			High
27	Hist. Arch.	Coast Range Tunnel Workers' Construction Site and Water Shaft	circa 1930			High
28	Hist. Arch.	Homestead-era Site	late 1800s		one house	High
29	Hist. Arch.	McDonald or Frager Cabin Site	circa 1906			High
30	Hist. Arch.	Charles McLaughlin Property Homestead Site	circa 1878		one structure	High
31	Hist. Arch.	Charles McLaughlin Property Homestead Site	circa 1878		one structure	High
32	Hist. Struct.	Mine Shaft				Low
33	Hist. Struct.	Hetch Hetchy Coast Range Tunnel	1934	4		Moderate
34	Hist. Struct.	Hetch Hetchy Coast Range Tunnel Pipeline Section with Alameda East and West Portals	1934			Moderate
35	Hist. Arch.	Homestead-era Site	circa 1906		one structure	High

in establishing the existence and location of early structures and features. Both *San Francisco Water*, a quarterly magazines published by the Springs Valley Water Company during the 1920s, as well as Hanson's (1985) narrative of the San Francisco Municipal Water Department, offered a great deal of historical information including maps and numerous photographs which served as visual aids for locating resources.

Although map sources exist throughout the Bay Area, the major collection at the University of California Doe Library Map Room in Berkeley was most useful. The Historical Atlas Maps of both Santa Clara and Alameda Counties, which were published by Thompson and West in 1876 and 1878, respectively, were examined in order to locate early homestead property owners, structures and school districts. Official maps of Santa Clara and Alameda Counties, dating from the late 1800s through the early 1900s, were helpful in illustrating the stability and succession of property ownership over time as well as in establishing the sites of early school houses. The United States Geological Survey topographic maps, available from the late 1890s, were important in tracing rancho boundaries as well as documenting structures within the watershed.

The following are the major historic property listings reviewed: the *National Register of Historic Places*, the *California Inventory of Historic Resources*, the *California Historical Landmarks, Five Views: An Ethnic Sites Survey for California* and the *Historic Civil Engineering Landmarks*. The Alameda County Planning Department's listing of State and National landmarks in Alameda County, the Santa Clara County Planning Department's Heritage Resource Inventory, the Pleasanton Planning Department's General Plan Historic Buildings, Table VII-2 and the Milpitas Planning Department's Register of Cultural Resources were also consulted.

FIELD INSPECTION

David Chavez and Jan Hupman drove much of the watershed area and inspected most of the known and recorded cultural resources. They also identified probable locations for many of the historic archeological sites and mapped terrain that revealed environmental factors favorable to the presence of prehistoric sites. Field trips were accomplished in late June, July and early August 1993.

Phillip and Andrew Galvan, Mission San Jose Native Americans, accompanied the study team and identified the prehistoric/ethnohistoric sites of Alisal and El Molino.

ORAL INTERVIEWS

The location of early homestead as well as water company structures and features were confirmed and augmented through oral interviews with current and former water company employees and/or long-time residents of the watershed including George Lester, Mark Mueller, Tim Coopman, Frank Marino, Jake DeLopez, Don Vieux and John Covo. The Galvans were interviewed regarding the history of the local Native American village sites and ethnohistorical use of the watershed.

NATIVE AMERICAN CONSULTATIONS

The California Native American Heritage Commission was contacted regarding cultural resources management issues; a list of most likely descendants for the Alameda regional was provided. Correspondence with the listed individuals has produced little formal response to date. However, Native American consultation should continually be pursued as cultural resources management programs are implemented that effect sites potentially important to the Native American community.

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LIST OF KNOWN CULTURAL RESOURCES

KNOWN CULTURAL RESOURCES OF THE ALAMEDA WATERSHED

The following is a summary of the archaeological and historical resources located on the Alameda Watershed lands. The mapped locations of these resources are exempt from public disclosure but will be on file with the San Francisco Water Department.

1. Four wells; "O" Line. Potable water from these wells is pumped southward via pipeline to the Castlewood Reservoir. At one time the water department operated over eighty wells in the Livermore Valley. The water from these wells was pumped via pipeline to the Sunol Water Temple and, thus, into the water system (Marino 1993).

2. Five wells; "F" Line. The water from these wells is used for irrigation only (Marino 1993).

3. Five wells; A Line. These wells have been abandoned (Marino 1993).

4. Homestead-era, two-story house, circa 1906. A three-structure complex stood on this property around 1900, however, only a house remains. Currently palm trees and other heavy vegetation surround the boarded-up structure. This land was owned by members of the Bernal family into the late 1800s; by the turn of the century it had been acquired by SVWC (Thompson and West 1878; Nusbaumer and Boardman 1900).

5. Castlewood Reservoir and nearby Chlorination Building. The water stored in this reservoir is used by the Castlewood County Club, which is responsible for pumping the water to their property (Marino 1993). 6. Alisal (elder trees) or Chumison (Native American name). This ethnohistoric village existed until the turn of the century. A roundhouse, which held 100 people, was evidently present at the site (Galvin and Galvin 1993).

7. Brightside Chlorination Building, Tanks and Meter Gate (1901) and Weir (1901-1902). These structures was built by Spring Valley Water Company around the turn of the century (Metcalfe 1913:77; Marino 1993).

8. Brightside Cottage, 1907. This complex, which was located south of the Western Pacific railroad tracks, included a cottage, privy and watertank (Metcalfe 1913:78). Sometime after 1950 the structures were razed or burned down.

9. Homestead-era structure, circa 1906. One structure stood on this site during the early decades of the twentieth century, but it is no longer present. The property appears to have been owned by the Blake family from at least 1878; by 1915 it had been purchased by SVWC (Thompson and West 1878; Nusbaumer and Boardman 1900).

10. Sunol Dam, 1900. Also known as Silver Springs Dam, this 28-foot- high, 135-feet-long, 8-foot-wide concrete dam, which is entirely submerged, served to back up the Alameda Creek "flow and keep the gravels flooded. A system of underground concrete galleries and perforated pipes collected the water percolating through the gravel beds, giving a dependable yield of approximately five million gallons daily during years of average precipitation" (Myers 1977:23; Metcalfe 1913:71; Vieux 1993).

11. Chlorination Building, circa 1900. This structure was built by Spring Valley Water Company around the turn of the century (Marino 1993).

12. Old House. This site consists of a collapsed house with only a foundation remaining. The former structure does not show on early maps, however, it appears to have been situated on land owned by Charles Hadsell from the early 1860s until around the turn of the century. The property had been acquired by the SVWC by 1900 (Nusbaumer and Boardman 1900; SVWC 1924:6; Marino 1993).

13. El Molino. This marks the site of a permanent, prehistoric and, later, ethnohistoric, Native American village. During the Spanish period, native people living at this village were forced to plant and cultivate grain, which they later processed or milled (molino) (Galvin and Galvin 1993).

14. Sunol Water Temple, 1900-1910, is listed in the California Inventory of Historic Resources and the Historic Civil Engineering Landmarks. Water from Calaveras Reservoir, Sunol gravel beds and the Pleasanton wells flowed to the Sunol Water Temple, which was constructed over a complex of forebays and filter galleries. Design by architect Willis Polk, the temple rests on a base 36-inches in diameter and consists of twelve columns rising 35-feet in height. From the ground level of this classic, graceful temple, people could observe the water passing through on its way to San Francisco. Just south of the Water Temple, in an open area, is a concrete fountain-type structure. This marks the location of a picnic and playground that was open to the public soon after the Water Temple was built (SVWC 1922:5; Eastman 1925:1; Myers 1977:23; CIHR 1976:107).

15. This resource consists of a prehistoric archaeological site (Luby 1992), currently under investigation. Recent survey and test excavation efforts have revealed a cultural deposit that has yet to be recorded and assigned a State number.

16. Adobe House, circa 1850. This is the approximate location of an early, Mexican-era adobe structure that was probably associated with the Sunol family holdings (Hendry and Bowman 1940:638-639).

17. Antonio Sunol Adobe, circa 1845. Although at least one source maintains that the Sunol Adobe was razed around 1930, when the San Francisco Water Department took over the property from SVWC (Hendry and Bowman 1940:637), most accounts contend that, although much altered, it currently serves as the Water Department Headquarters. Originally built by Antonio Sunol between 1845 and 1850, it was located on the land Charles Hadsell purchased from the Sunol family in the early 1860s Measuring 42 feet x 30 feet. Hadsell "enlarged and rehabilitated" the structure, which he evidently lived in until he sold his property to SVWC around 1900. SVWC used the building, known as Sunol Cottage, throughout their tenure on the land (SVWC 1924:6; Ambro 1992:17).

    Today the Headquarters includes the main office building (Sunol Adobe), superintendent's dwelling and guest cottage, nineteenth- century barn and walnut drying building as well as additional outbuildings (Woodbridge 1991). The footings from a 1910, 240-foot- long suspe-nsion footbridge over Arroyo de la Laguna are situated directly behind the Water Department buildings (Marino 1993).

18. Adobe Blacksmith Shop Site, late 1840s/early 1850s. Towards the end of the rancho era, a blacksmith shop was constructed approximately 1/5 mile north of the Sunol Adobe, on the east bank of Alameda Creek (Hendry and Bowman 1940:637-638).

19. Sunol School, circa 1885. This school, located east of the town of Sunol, was constructed around 1885 and was still depicted on maps as late as 1915 (Baker 1914:36; Haviland 1915).

20. Vallecitos School, 1865. This school was established in 1865 in Scott's Store. A permanent schoolhouse was later constructed on the north bank of Vallecitos Creek and was still depicted on maps as late as 1915 (Baker 1914:446; Haviland 1915).

21. Mendoza Barn, circa 1900. Located on the south side of San Antonio Creek, this standing barn is on land owned by Pedro Saissett until it was purchased by SVWC between 1900 and 1907 (Thompson and West 1878; Nusbaumer and Boardman 1900; Haviland and Prather 1907).

22. Homestead-era house, late 1800s. A house was located on the north side of San Antonio Creek on land owned by Pedro Saissett until it was purchased by SVWC between 1900 and 1907 (Thompson and West 1878; Nusbaumer and Boardman 1900; Haviland and Prather 1907). The structure had evidently burnt down around the turn of the century and no remains are visible (Vieux 1993).

23. D. Sullivan Homestead, late 1800s. Although this site does not appear on early maps, some evidence of historical scatters exists in the area (Vieux 1993). By 1900 the Sullivan family had bought this 1,815-acres parcel from Juan Lacoste. Although SVWC had purchased most of the former rancho lands by 1907, the Sullivans continued to hold their land past 1915 (Thompson and West 1878; Nusbaumer and Boardman 1900; Haviland and Prather 1907; Haviland 1915).

24. Homestead-era house, late 1800s. Although this structure does not appear on early maps, a late-nineteenth-century house was evidently located in this area (Vieux 1993). The land was owned by Juan Lacoste until the turn of the century when it was purchased by D. Sullivan (see Resources No. 25) (Thompson and West 1878; Nusbaumer and Boardman 1900).

25. La Costa School, circa 1900. Palm trees and steps, leading up to a former structure, mark the site of the La Costa Schoolhouse. This schoolhouse was established by the turn of the century on the south fork of San Antonio Creek. By 1915 it had closed its doors (Nusbaumer and Boardman 1900; Haviland 1915; Vieux 1993).

26. Homestead-era structure, circa 1906. One structure was situated on land owned by N. M. Sunol until it was purchased by SVWC between 1900 and 1907 (Thompson and West 1878; Nusbaumer and Boardman 1900; Haviland and Prather 1907). It was razed or burned down sometime after 1950.

27. Labor Camp for Coast Range Tunnel, circa 1927-1934. This site is the location of a labor camp that housed Coast Range Tunnel construction workers. A watertank, wench blocks, tailings and other evidence of the camp still remain. In addition, a water shaft is also located in the area (Marino 1993; Vieux 1993).

28. Homestead-era house, late 1800s. Although no structure appears in this area on early maps, a house was at one time located on this site. The land was owned by Juan Lacoste until 1900 when it was sold to D. Rhorer and D. W. Coons. SVWC purchased the land by 1907 (Thompson and

West 1878; Nusbaumer and Boardman 1900; Haviland and Prather 1907). The structure had evidently burnt down around the turn of the century and no remains are visible (Vieux 1993).

29. McDonald or Frager Cabin, circa 1906. This site consisted of a cabin that was razed sometime after the mid-1900s. The land was owned by L. Dotta until the turn of the century when it was purchased by A. Borel. By 1907 it had been sold to SVWC (Thompson and West 1878; Nusbaumer and Boardman 1900; Haviland and Prather 1907). Some historical scatter marks the located of the former cabin (Vieux 1993; Lester 1993).

30. R. Charles McLaughlin property, circa 1878. One structure is recorded on this 640-acre parcel owned by Charles McLaughlin, railroad contractor and real estate speculator. By 1878 he had acquired dozens of "railroad land" sections, which were spaced between the government sections throughout the Amador-Livermore Valley. Within the Alameda Watershed lands, in both Santa Clara and Alameda Counties, McLaughlin owned thousands of acres, which he likely leased to ranchers and farmers (Thompson and West 1876, 1878; Loomis 1986:36). The land on which this structure stood was purchased by A. Borel by 1900. By 1907 three-quarters of the section had been sold to SVWC (Thompson and West 1878; Nusbaumer and Boardman 1900; Haviland and Prather 1907).

31. R. Charles McLaughlin property, circa 1878. One structure was situated on this section owned by Charles McLaughlin (Thompson and West 1878). It shares a common history with Resource No. 30.

32. Mine Shaft. An abandon mine shaft is located on this site (Vieux 1993).

33. Hetch Hetchy Coast Range Tunnel, 1927-1934, is listed in the Historic Civil Engineering Landmarks. This 29-mile-long feature, which includes 25 miles of tunnel, a half mile of siphon/pipeline and an additional 3.5-mile-long tunnel, extends from Tesla Portal south of Tracy to Irvington Portal near Mission San Jose. The tunnel, which is 10.5-feet in diameter and entirely lined with concrete, has the capacity to carry 450 million gallons of water per day (Myers 1977:23-24; Hanson 1985;38).

34. Hetch Hetchy Coast Range Tunnel Siphon/Pipeline Section between Alameda East and West Portals, 1934. The Coast Range Tunnel is breached by a pipeline as it crosses Alameda Creek. The pipeline is disconnected and reconnected to the tunnel at the east and west portals, respectively (Marino 1993).

35. Homestead-era structure, circa 1906. One structure was situated on this former 1878 Rogan Ranch property, which by 1900 had been subdivided into 24 parcels. This building was situated on the 36- acre No. 16 parcel. By 1915 the land appears to have still been private owned (Thompson and West 1978, Nusbaumer and Boardman 1900; Haviland 1915).

36. Mrs. O'Neil Homestead, circa 1878. One structure was situated on the 81-acre parcel owned by Mrs. O'Neil from at least 1878 until 1900. By 1900 the property had been purchased by W. Harland and it appears he sold it to SVWC by 1915 (Thompson and West 1978, Nusbaumer and Boardman 1900; Haviland 1915).

37. Shake(sp?) Family Homestead, circa 1906. Nothing remains of the two structures that were at one time situated on this property (Marino 1993). The 137-acre parcel was owned by B. F. Lee from at least 1878. By 1900 the land had been sold to M. Dougherty who, in turn, sold it to SVWC by 1915. The Shake family evidently rented the land from the water company (Thompson and West 1978, Nusbaumer and Boardman 1900; Haviland 1915).

38. Rosedale School, circa 1900. This school was established by the turn of the century on the west side of Calaveras Creek. By 1915 enrollment had fallen as farming family moved away and classes were no longer being held at this schoolhouse (Nusbaumer and Boardman 1900; Haviland 1915).

39. F. Pincle Homestead, circa 1878. One structure was located on this 80-acre parcel owned by the Pincle family by at least 1878. By 1900 the building was enclosed within A. A. Moore's 882-acre property, which by 1915 had been purchased by SVWC (Thompson and West 1978, Nusbaumer and Boardman 1900; Haviland 1915).

40. Hollenbeck Family Homestead, circa 1878. One structure was situated on this 160-acre parcel owned by the Hollenbeck's by at least 1878. From the turn of the century it shared a common history with Resource No. 39 (Thompson and West 1978, Nusbaumer and Boardman 1900; Haviland 1915).

41. Calaveras Dam Spillway, 1925. When the Calaveras Reservoir is full, this 1450-foot-long spillway is capable of carrying 20,000 cubic feet of water per second past the dam and discharging it into Calaveras Creek. Constructed in 1925, the 18-foot-deep, 29-foot-wide spillway involved the excavation of approximately 200,000 cubic yards of earth and is lined with 6,000 cubic yards of reinforced concrete (Espy 1924:9; Elliott 1925:4).

42. Blue Stone House, circa 1925. This structure was likely built after the construction of Calaveras Dam (Lester 1993).

43. Calaveras Dam Bridge over Spillway, 1925. This narrow, concrete bridge is presumed to have been built at the same time as the Calaveras Dam Spillway.

44. Adit Tower, 1925. This outlet tower is located over the concrete- lined shaft that houses the Calaveras Reservoir control gates. A causeway leads to the tower, which was constructed in an architectural style similar to the Sunol Water Temple (Elliott 1925:4; SVWC 1926b:8).

45. Calaveras Dam, 1913-1925. The lower portion of this dam was built up by the hydraulic fill method; the upper portion consists of a rolled clay core supported on either side by loosely dumped material containing a large amount of rock. When finished in 1925 the dam stood 220 in height above bedrock with a crest length of 1,200 feet and a water capacity of 32 billion gallons. The reservoir that back- up behind the dam is approximately 3 miles long and covers 1,450 acres (Dam Plaque; Elliott 1925:3; Hanson 1985:16).

46. Calaveras Filtration Plant Complex includes a Chlorination Building and an Aerator Building, circa 1925. These structures were built in association with the Calaveras Dam and Reservoir. The Aerator Building was removed in 1992 (Marino 1993).

47. Calaveras Dam Watershed Keeper's Complex and Barn, circa 1900. The two present houses, constructed circa 1970, were built near the location of two earlier dwellings. The first dwelling was a nineteenth-century house, razed in 1938; it was replaced by a dwelling that was removed in the 1960s. The original, late-1800s barn, however, still remains on the property (Marino 1993; Covo 1993).

48. Alameda Diversion Tunnel, 1924-1926. This approximately two-mile- long tunnel was bore through a ridge that separates Calaveras Reservoir from the Upper Alameda Creek. The water from the creek was then diverted into Calaveras Reservoir via the tunnel (Elliott 1924:7, 1925:3; Marino 1993).

49. Alameda Diversion Tunnel Dam, 1924-1925. This dam blocks the flow of water down Upper Alameda Creek and forces it into the Alameda Diversion Tunnel.

50. D. Dyer Homestead, circa 1876. One structure was located on a 80- acre parcel owned by D. Dyer by at least 1876. By 1890 it was enclosed within D. Jeffrey's 160-acre property. The SVWC had acquired the land by 1903 (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903).

51. David and Tom Williams property, circa 1876. The Williams Brothers, who owned several parcels within the watershed as well as a soda works business in San Jose, were basically cattle ranchers (Loomis 1986:38). One structure was situated on this 160-acre parcel by 1876. It may have housed members of the Williams family or, perhaps, ranch workers. By 1890 the property was totally owned by David Williams; by 1903 the 160-acres had been purchased by Isaac Castle. SVWC had acquired the land by 1914 (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903, 1914).

52. D. B. Frink Homestead, circa 1890. Although this 160-acre parcel was vacant in 1876, by 1890 it was owned by the Frink family. The site of the homestead is marked by a water trough. By 1903 the 160 acres was included in J. W. Rath's 320-acre property and in 1914 was owned by SVWC (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903, 1914; Covo 1993).

53. School and two-structure complex, circa 1880. The remains of a well, almond trees, scattered lumber and a downed cypress tree mark the site of the Oak Grove School. Although it does not appear on any historical maps, this school was evidently constructed around 1880. The school appears to have existed only a few years and had a very small number of students (Loomis 1986:36-37; Covo 1993).

54. S. G. Gale Homestead, circa 1890. This site, which at one time included a structure, can be located by the presence of several almond trees. In 1876 the land was vacant, however, by 1903 the Gale's 160 acres was included in J. W. Rath's 320-acre parcel. SVWC had acquired the land by 1914 (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903, 1914; Covo 1993).

55. Parks Family Homestead, 1880. Located just outside the watershed, this site is currently marked by abandoned farm equipment and a late-1800s house. William Parks, a native of New York, arrived in California in 1877 and three years later settled on 160-acres of vacant land along Oak Ridge and constructed a home. The Park family continued to own their property until at least 1929. The father of seven children, for years Parks and his sons ran cattle on their land as well as

on 14,000 acres leased from SVWC (McMillan and McMillan 1929; Loomis 1986:37; Covo 1993).

56. R. Charles McLaughlin property, circa 1876. One structure was recorded on this section owned by Charles McLaughlin in 1876 (see Resource No. 30). In 1903 it had been acquired by the Suburban Company and by 1914 had become part of the SVWC holdings (Thompson and West 1876:28; McMillan 1903, 1914).

57. This resource consists of an unconfirmed prehistoric archaeological site reported by San Francisco Water Department personnel as a midden with pestles present. No cultural deposits were observed at the reported site location during current field review.

58. W. Dixson Homestead, circa 1876. One structure was located on this 160-acre parcel owned by W. Dixson by at least 1876. By 1890 the building was enclosed within David Williams' 480-acre property and by 1903 it was situated on the 120-acre parcel owned by Mary Williams. SVWC had obtained this land by 1914 (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903, 1914).

59. James Fennell Homestead, circa 1876. One structure was built on this 160-acre quarter section owned by the Fennell family from at least 1876; by 1914 it had been sold to SVWC (Thompson and West 1876:28; McMillan 1903; 1914).

60. David and Tom Williams property, circa 1876. One structure was situated on this 80-acre parcel owned by the Williams Brothers (see Resource No. 51) from at least 1876 until 1890. By 1903 the building lay within Isaac Castle's 460-acre property and eleven years later the land was owned by SVWC (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903, 1914).

61. John Carrick Homestead, circa 1860. One structure was located on the Carrick family land, which consisted of 160, 506 and 240 acres in 1857, 1890 and 1903, respectively (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903). John Carrick, a native of Scotland, arrived in the Milpitas area during the 1850s. By 1857 he had purchased at least 160-acres of land and in 1862 served as a trustee on the board of the Calaveras School District. By 1874 he and his family were living along the southeast edge of the Calaveras Valley and growing alfalfa on which they pastured their livestock. The Carrick's had sold their land to SVWC by 1914 (Alley et al. 1881:643; McMillan 1914; Loomis 1986:8, 20, 28, 38).

62. Alex Anderson Homestead, circa 1860. This site consisted of two structures and a barn; the approximately 130-year-old house (without foundation) as well as a bunkhouse both burnt down in the spring of 1993 -- the barn still stands on the property (Alameda Watershed staff 1993). By 1890 this property was part of a 320-acre parcel owned by David and Tom Williams; Mary Williams' 80 acres enclosed the complex by 1903. The Williams' family sold their land to SVWC by 1914 (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1903, 1914).

63. John Carrick and the Williams Brothers property, circa 1876. One structure was situated on this 160-acre parcel owned by John Carrick and the Williams Brothers (see Resource No. 51) by at least 1876. The structure was surrounded by 506 acres of Carrick family land in 1890 and from then on shares a common history with Resource No. 61 (Thompson and West 1876:28; Herrman Brothers 1890).

64. J. Alter Homestead, circa 1876. This structure was situated on this 67-acre parcel owned by J. Alter by at least 1876. E. J. and C. F. Preisker purchased the property by 1890; by 1914 they had sold out to SVWC (Thompson and West 1876:28; Herrman Brothers 1890; McMillan 1914).

65. John Patton Homestead, circa 1876. This structure was located on a 160-acre quarter section owned by Irish immigrant John Patton from at least 1876. By 1914 the land had been acquired by SVWC (Thompson and West 1876:28; McMillan 1903, 1914; Loomis 1986:38).

66. J. McDonald Homestead, circa 1876. This structure was located on a 161-acre parcel owned by J. McDonald from at least 1876 until 1890. The SVWC had purchased the land by 1903 (Thompson and West 1876:25; Herrman Brothers 1890; McMillan 1903).

67. Sherman Homestead, circa 1876. John Sherman, a native of New York, arrived in California in 1854 and immediately set out for the Sierra foothills in search of gold. Although he had settled in the Santa Clara Valley by 1876 and owned 417 acres of land at the south end of the Calaveras Reservoir, he and other Sherman family members may have settled on the property earlier. The property consisted of a 332-acre parcel north of Calaveras Road and a 85- acre lot south of the road. On May 1, 1861 a big dance was evidently held in the Sherman barn and the following year a Sam Sherman gave a piece of his land to the Calaveras School District, on which was built a one-room schoolhouse. A Sherman-family structure was situated just south of the school. The site of both the school and the structure, located on the 332-acre parcel, were owned by the Shermans until at least 1890; by 1903 they had been acquired by SVWC and today lay beneath the waters of the Calaveras Reservoir. Nevertheless, in 1874 John Sherman was in possession of the 417 acres and had planted 200 acres in wheat, 10 acres in barley, 18 acres in flax and the remainder in hay. One structure appears on the 85-acre parcel in 1876. By 1890 the land had been sold to M. King who, in turn, sold it to SVWC by 1914 (Thompson and West 1876:25: Alley et al. 1881:305; Herrman Brothers 1890; McMillan 1903, 1914; Loomis 1986:6, 16, 20, 27).

68. D. Cullen Homestead, circa 1876. One structure was situated on this 82-acre parcel owned by D. Cullen from at least 1876. By 1914 it had been purchased by SVWC (Thompson and West 1876:25; McMillan 1914).

69. Mrs. Frederick Brandt Homestead, circa 1876. One structure was located on this 167-acre parcel owned by the widow of Frederick Brandt from at least 1876. SVWC had acquired the property by 1914 (Thompson and West 1876:25; McMillan 1914).

70. Joseph R. Weller Homestead, circa 1876. In 1850, Joseph Weller and his brother, Abraham, left their home in New York and came to try their luck in the Coloma mining district. By 1852 Joseph Weller had settled in the Santa Clara Valley and six years later had been appointed assistant postmaster as well as a justice of the peace in Milpitas. Over the next few years he evidently operated a blacksmith shop, however, by 1874 he had purchased 197 acres of valley land near Milpitas and established a dairy. This dairy was likely successful because Weller also bought 280 acres of land in the hillside northeast of town, were he raised hay and pastured his livestock. One structure appears on this latter property by 1876. From at least 1890 until 1903 he owned an additional 335 acres, which bordered his property on the north (see Resource No. 71). Present-day Weller Road runs north/south through Joseph Weller's former land (Thompson and West 1876:25; Alley et al. 1881:646-647; Herrman Brothers 1890: Loomis 1986:4-7, 9, 29).

71. H. G. Bultey Homestead, circa 1876. In 1876 one structure was located on this 335-acre parcel owned by H. G. Bultey. By 1890 this property had been purchased by Joseph Weller and by 1914 was owned by SVWC (Thompson and West 1876:25; Herrman Brothers 1890; McMillan 1914).

APPENDIX A
WETLANDS REGULATIONS

JURISDICTIONAL WETLANDS

To determine which wetlands are subject to COE' jurisdiction (i.e., jurisdictional wetlands), a wetlands delineation must be performed. Three criteria are considered: (1) evidence of inundation or saturation by surface or groundwater for at least two weeks during an average rainfall year (hydrology), (2) a prevalence of wetland vegetation (hydrophytes) if the site is undisturbed, and (3) typical wetland (hydric) soils, that is, soils formed under saturated, anaerobic conditions. Generally, riparian areas do not meet the criteria for delineation as a wetland, except for that portion of a stream corridor or lake margin that lies within the line of "ordinary high water."

In 1987 the COE published a manual which standardized the manner in which wetlands were to be delineated nationwide. While the manual was effective in most circumstances, conflicts arose in certain instances when the COE' delineation of a wetland conflicted with that of other federal agencies which had their own wetland definitions. Consequently the COE, EPA, Soil Conservation Service (SCS) and U.S. Fish and Wildlife Service (USFWS) in 1989 published a new "unified" method for wetland delineation. Under the 1989 methodology, an area meeting the minimum soils criteria and supporting plant species able to survive occasional saturation was considered a jurisdictional wetland if the soil, 6 to 18 inches below the surface, showed evidence of saturation for as little as seven consecutive days during the year.

Public and legislative concern regarding the 1989 methodology led to a new effort to refine the delineation approach. As a result, on August 14, 1991 a proposed new wetland delineation manual was published in the Federal Register for public review. The proposed manual, sponsored by the same four agencies, is intended to replace the 1989 manual. The proposed manual would substantially increase the standards necessary to meet the wetland hydrology test by requiring that an area be inundated or saturated to the surface for at least 15 and 21 consecutive days, respectively. Most recently, the COE has provided guidance through its Districts that, effective August 17, 1991, the 1987 manual is to be used to identify and delineate wetlands potentially subject to Section 404 regulation.

If it is likely that a project would encroach upon a potential wetland area or that a potential wetland area would be altered, it is necessary to determine the extent to which "waters of the United States" exist on a property. A written request is made to the Chief of the Regulatory Section, Corps of Engineers, accompanied by a description of the property, and a map documenting the findings of a preliminary wetland delineation. The COE analyzes this

information and conducts their own field visit to confirm the wetland delineation and to identify areas under the COE' jurisdiction subject to Section 404 permit requirements.

Once the extent of COE' jurisdiction is known, the next step is to determine whether there are practicable alternatives, either on- or off-site, which would avoid filling wetlands or minimize filling wetlands, such as project alteration. Only as a last resort will the COE and EPA accept creation of new wetlands or enhancement or restoration of existing wetlands as mitigation.[1] This sequencing of mitigation is generally in keeping with the current Federal policy of "no net loss" of wetland acreage.

U.S. ARMY CORPS OF ENGINEERS (COE) PERMITTING PROGRAM

The COE' current Nationwide permit program, specifically Nationwide Permit No. 26 (33 CFR Section 330.5), provides a mechanism for processing and review of activities which would affect fewer than ten acres of wetland and other waters in areas that lie "above the headwaters." Headwaters are defined as having a mean annual flow of five cubic feet per second or less (33 CFR Parts 320 through 330), or a flow of less than five cubic feet per second more than 50 percent of the time. Wetlands that are adjacent to "waters of the U.S." or tributary to these waters are not eligible for a NWP #26 (Lawrence 1993). This means that for almost all fills -- within wetlands, surrounding SFWD reservoirs, and associated with tributary streams -- would require an individual permit.

If one to ten acres of wetland fall within the definition of "above the headwaters" or constitute an "isolated wetland," the COE must be notified of any proposed action that would fill that wetland. The COE may elect to process an individual permit or allow the proposed wetland fill to proceed under the Nationwide Permit. Generally, the closer the proposed fill area is to one acre, the greater the probability that a Nationwide Permit may be issued. For filling of wetlands which fall outside this definition and/or are greater than ten acres, an application for an individual permit must be filed with the COE, requiring a thorough environmental and public interest review and public notice prior to the issuance or denial of a permit. The COE would issue a public notification allowing for a 40-day comment period for the appropriate agencies and for

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1 Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation Under the Clean Water Act Section 404 (b) (1) Guidelines, 1990.

the public. If the project meets the conditions of the Nationwide permit program, no formal notification of other public agencies by the COE or public review is required.

REGIONAL WATER QUALITY CONTROL BOARD (RWQCB)

The Regional Water Quality Control Board can require a project proponent to obtain a Section 401 (Clean Water Act) water quality certification for Nationwide permits granted by the COE. For less than one acre, the Board issues a waiver, provided the applicant is also applying to the California Department of Fish and Game for a Stream Alteration Agreement as noted below. The RWQCB has 60 days to issue this waiver. Between one and two acres, a waiver could also be issued but only after a thorough review of any agency or public comments during the 40-day comment period on the Corps' public notice (assuming that the COE has required an individual permit). For more than two acres of wetland removal, the RWQCB requires a mitigation plan, a public hearing, and approval of the water quality certification by the State Water Resources Control Board as an item on their agenda.

APPENDIX B
AQUATIC HABITAT CLASSIFICATION SYSTEM

SUMMARY OF FISHERY RESOURCES CLASSIFICATION SYSTEM

INTRODUCTION

During the last couple of years, fisheries biologists have begun to try to halt and then reverse the loss of biodiversity in California. Although the loss of biodiversity in aquatic systems is presumably occurring among all groups of organisms, only fish are well enough studied to provide a good idea of the actual trends. Sixty-two percent of the native fishes are in need of immediate special protection. Extinction of fish taxa is now occurring at the rate of one every six years. To protect California's aquatic biota, both in the long and short terms, a framework has been developed to systematically protect California's native aquatic fauna. This framework focuses on developing a statewide system of protecting waters that have as their primary management goal the protection of aquatic biodiversity, called Aquatic Diversity Management Areas (Moyle and Yoshiyama 1992). ADMAs are roughly equivalent to the Significant Natural Areas recognized by the California Department of Fish and Game.

The original authors defined the ADMA as a water body that had as its top management priority the maintenance of local biodiversity (Moyle and Yoshiyama 1992; Moyle and White 1990). Other uses were to be permitted, but they were to be secondary to the primary goal. After speaking with Dr. Peter Moyle, one of the author's of the ADMA Classification System, it became clear that the ADMA system was state-of-the-art and that the list of ADMAs was rapidly expanding.

Proponents of the ADMA Classification System include the California Department of Fish and Game (CFG) and the Environmental Protection Agency, through the San Francisco Estuary Project (SFEP). The Natural Heritage Division of the CFG is currently incorporating the ADMA System into its GIS database. As part of its draft "Action Plan for Aquatic Resources", the SFEP has recommended the identification and protection of remnant stream habitats containing indigenous and endemic species. Specific measures proposed by the Plan include: (1) creating an inventory of streams within the Bay-Delta region to determine the current status of native stream fishes and riparian communities; and, (2) proposing the designation of stream preserves, encompassing specific drainages or stream reaches to protect identified stream fish and riparian communities (EPA 1992).

CLASSIFICATION SYSTEM

The proposed classification system for California's Inland Waters is present here in full. The system recognizes six major provinces: Sacramento-Joaquin; Klamath and North Coast; Great Basin; Colorado River; Southern California Coastal; and Artificial Habitats. In each province standing water, ephemeral and permanent, is distinguished from flowing waters, ephemeral and permanent.

To use the ADMA Classification System, the riverine and lacustrine systems within the Peninsula and Alameda Watersheds were first broken down into specific Aquatic Habitat Types. Although numerous habitats have been identified in the ADMA Classification System, most of the Aquatic Habitats within the two watersheds will have to be added to the existing Classification System. The reason is that the current ADMA Classification System includes *Natural Stream Systems* primarily, rather than *Regulated Steam Systems* (e. g., reservoirs and associated regulated streams). Although the ADMA Classification System includes *Regulated Stream Systems* generally, in the form of ARTIFICAL HABITATS (F0000), the subcategories within the ARTIFICIAL HABITATS Classification are limited. At this juncture, only the Pond Habitat and Reservoir Habitat within the Peninsula Watershed have ADMA Classification Numbers, F1211 and F221, respectively. It is anticipated that the rest of the Aquatic Habitat Types will fall into the F20000 Classification: Flowing Waters. However, the precise cataloguing number for each is not known at the present time.

CLASSIFICATION SYSTEM FOR CALIFORNIA'S INLAND WATERS
(Moyle and Ellison, 1991)

A0000 SACRAMENTO-JOAQUIN PROVINCE

A1000 STANDING WATERS

A1100 **Ephemeral Waters**
- A1110 Floodplain pool
- A1120 Vernal Pool
  - A1121 Northern claypan pool
  - A1122 Northeast volcanic vernal pool
- A1130 Playa lake
- A1140 Rock outcrop pool
- A1150 Alpine pool

A1200 **Permanent Fishless Waters**
- A1210 Alpine lakes
- A1220 Northeast volcanic perennial pools
- A1230 Caldera lakes
- A1240 Dystrophic ponds/lakes
- A1250 Saline ponds/lakes
- A1260 Valley marsh
- A1270 Northern volcanic pools

A1300 **Permanent Waters with Fish**
- A1310 Goose Lake
- A1320 Tulare basin lake
- A1330 Sloughs, oxbow lakes, and backwaters
- A1340 Clear Lake drainage
  - A1341 Clear Lake
  - A1342 Blue Lakes
- A1350 Big Lake
- A1360 Coastal lagoons

A2000 FLOWING WATERS

A2100 **Ephemeral Streams**
- A2110 Alpine snowmelt stream
- A2120 Conifer forest snowmelt stream
- A2130 Foothill/valley ephemeral stream

A2200 **Permanent Streams, Goose Lake Drainage**
- A2210 Fishless alpine stream
- A2220 Redband trout/lamprey spawning stream
- A2230 Resident redband trout stream
- A2240 Goose Lake sucker/speckled dace stream
- A2250 Valley tui chub stream

A2300 **Permanent Streams, Pit River Drainage**
- A2310 Fishless Streams
  - A2311 Glacial melt stream
  - A2312 Alpine stream
  - A2313 Spring stream

A2314 Forest stream
A2320 Low-order trout streams
A2321 Pit River rainbow/redband trout stream
A2322 McCloud River redband trout stream
A2330 Pit River tributaries
A2331 Speckled dace/Pit sculpin stream
A2332 Squawfish/sucker valley stream
A2333 Modoc sucker stream
A2334 Rough sculpin/Shasta crayfish spring stream
A2340 Canyon rivers
A2341 Lower Pit River (Hardhead/tule perch river)
A2342 Lower McCloud River
A2400 **Permanent Streams, Central Valley Drainage**
A2410 Fishless low-order tributaries
A2411 Alpine stream
A2412 Forest stream
A2413 Spring
A2420 Resident trout stream
A2421 Resident rainbow trout stream
A2422 Rainbow trout/cyprinid stream
A2423 Kern golden trout stream
A2430 Salmon-steelhead streams
A2431 Spring chinook stream
A2332 Steelhead stream
A2440 Low elevation streams
A2441 Valley floor river
A2332 Fall chinook salmon spawning stream
A2443 Hardhead/squawfish stream
A2444 Hitch stream
A2445 California roach stream
A2500 **Permanent Streams, Clear Lake Drainage**
A2510 Fishless low order streams
A2520 Resident trout stream
A2530 Cyprinic/catostomid stream
A2540 California roach stream
A2550 Seasonal lakefish spawning stream
A2600 **Permanent Streams, North Central Coastal Drainages**
A2610 Fishless low-order streams
A2620 Coastal rivers
A2621 Eel River
A2622 Russian River
A2623 Sacramento sucker/roach river
A2630 Steelhead streams
A2631 Fall steelhead only stream
A2632 Short-run coho stream
A2633 California roach/stickleback/steelhead stream
A2634 Summer steelhead stream
A2635 Central coast steelhead/speckled dace stream
A2636 Lower Russian River squawfish/sucker tributary

A2637 Coastal steelhead/sculpin stream
A2640 Chinook salmon spawning streams

B0000 KLAMATH AND NORTH COAST PROVINCES
B1000 STANDING WATERS
B1100 **Ephemeral Waters**
B1110 Dune pond
B1120 Alpine pond
B1130 Sag ponds
B1200 **Permanent Fishless Waters**
B1210 Alpine lakes (See A1210)
B1300 **Permanent Waters with Fish**
B1310 Dune pond
B1320 Coastal lake or lagoon
B1330 Klamath sucker/minnow lake

B2000 FLOWING WATERS
B2100 **Ephemeral Streams**
B2110 Seasonal stormcourse stream
B2120 Seasonal snowmelt stream
B2200 **Permanent Fishless Streams**
B2210 Coastal headwater stream
B2220 Interior headwater stream
B2300 **Permanent Streams with Fish**
B2310 Resident trout stream
B2311 Redband trout stream
B2312 Rainbow trout stream
B2313 Cutthroat trout stream
B2320 Mixed assemblage streams
B2321 Lower Klamath sculpin/dace/sucker stream
B2322 Rogue drainage trout/sculpin stream
B2323 Upper Klamath dace/sculpin stream
B2324 Upper Klamath chub/sucker stream
B2325 Klamath Spring stream
B2330 Anadromous fish streams
B2331 Eulachon/sturgeon/salmon spawning river
B2332 Fall/winter-run chinook river
B2333 Spring-run chinook/summer steelhead stream
B2334 Fall/winter-run steelhead stream
B2335 Short-run coho spawning stream
B2336 Cutthroat trout spawning nursery stream
B2337 Cutthroat/coho river (Smith River)

C0000 GREAT BASIN PROVINCE

C1000 <u>STANDING WATERS</u>

- C1100 **Ephemeral Waters**
  - C1110 Alkali playa lake
  - C1120 Mountain pool
  - C1130 Great Basin scrub pool
  - C1140 Rock pool
- C1200 **Permanent Fishless Waters**
  - C1210 Alpine lake/pond
  - C1220 Desert pools and ponds
    - C1221 Great Basin scrub perennial pool
    - C1222 Spring pool
  - C1230 Desert lakes
    - C1231 Playa lake
    - C1232 Mono Lake
    - C1233 Owens Lake
- C1300 **Waters with Fish**
  - C1310 Alpine lakes
    - C1311 Alpine lake/pond
    - C1312 Lake Tahoe
  - C1320 Eagle Lake
  - C1330 Honey Lake
  - C1340 Desert Springs
    - C1341 Lahonton desert spring
    - C1342 Armagosa desert spring
    - C1343 Owens desert spring
  - C1350 Desert marshes
    - C1351 Cottonball Marsh

C2000 <u>FLOWING WATERS</u>

- C2100 **Ephemeral Streams**
  - C2110 Alpine snowmelt stream
  - C2120 Conifer forest snowmelt stream
  - C2130 Great Basin scrub snowmelt stream
  - C2140 Desert wash
- C2200 **Permanent Fishless Streams**
  - C2210 Alpine streams
    - C2211 Glacial melt stream
    - C2212 Exposed alpine stream
    - C2213 Spring stream
    - C2214 Conifer forest stream
  - C2220 Desert streams
    - C2221 Desert scrub stream
    - C2222 Mohave desert stream
    - C2223 Amargosa desert stream
- C2300 **Permanent Streams with Fish**
  - C2310 Cutthroat trout headwater
  - C2320 Cutthroat trout/Paiute sculpin stream
  - C2330 Sucker/dace/redside stream

C2331 With cutthroat trout
C2332 Without cutthroat trout
C2333 Pine Creek (Lassen County)
C2340 Speckled dace stream
C2350 Whitefish/cutthroat, trout/sucker stream
C2360 Tui chub stream
C2370 Desert streams
C2371 Spring outflow
C2372 Amargosa River
C2373 Salt Creek
C2374 Owens River
C2375 Mohave River

:

D0000 COLORADO RIVER PROVINCE

D1000 <u>STANDING WATERS</u>

D1100 **Ephemeral Waters**
D1110 Desert playa lake
D1120 Salton Sink
D1130 Desert intermittent pool
D1140 Colorado River seasonal floodplain lake/pond
D1200 **Permanent Fishless Waters**
D1210 Desert spring
D1300 **Permanent Waters with Fish**
D1310 Colorado River floodplain lake/pond

D2000 <u>FLOWING WATERS</u>

D2100 **Ephemeral Streams**
D2110 Desert stream
D2200 **Permanent Fishless Streams**
D2210 Paiute Creek (desert perennial stream)
D2300 **Permanent Streams with Fish**
D2310 Colorado River
D2311 Main river
D2312 Sloughs and marshes

E0000 SOUTHERN CALIFORNIA COASTAL PROVINCE

E1000 <u>STANDING WATERS</u>

E1100 **Ephemeral Waters**
E1110 Vernal pools
E1111 Southern vernal pool
E1112 San Diego Mesa duripan pool
E1113 San Diego Mesa claypan pool (see E1112)
E1120 Sag pond
E1130 Dune lake/pond
E1200 **Permanent Waters**
E1210 Perennial playa lake
E1220 Coastal lagoon

E2000 <u>FLOWING WATERS</u>

- E2100 **Ephemeral Streams**
  - E2110 Stormcourse Stream
- E2200 **Permanent Fishless Streams**
  - E2210 Island permanent stream
- E2300 **Permanent Streams with Fish**
  - E2310 Steelhead spawning stream
  - E2320 Threespine stickleback stream
  - E2330 Arroyo chub/Santa Ana sucker stream
  - E2340 Resident trout stream

F0000 ARTIFICIAL HABITATS

F1000 <u>STANDING WATERS</u>

- F1100 **Ephemeral Waters**
  - F1110 Rice paddies
  - F1120 Wildlife refuges
  - F1130 Drainage and evaporation ponds
  - F1140 Irrigated land
- F1200 **Permanent Waters**
  - F1210 Ponds
    - F1211 Coldwater ponds
    - F1212 Warmwater ponds
    - F1213 Ornamental ponds
  - F1220 Reservoirs
    - F1221 Coldwater reservoirs
    - F1222 Coolwater stratified reservoirs
    - F1223 Warmwater reservoirs
    - F1224 Run-of-river reservoirs
    - F1225 Forebays
  - F1230 Flood pit lakes (gravel and rock quarries, etc.)

F2000 <u>FLOWING WATERS</u>

- F2100 **Ephemeral Streams**
  - F2110 Aqueducts
    - F2111 Main lines
    - F2112 Water delivery canals
  - F2120 Drainage ditches
    - F2121 Urban
    - F2122 Agricultural
    - F1223 Wetland
  - F2130 Irrigation ditches
  - F2140 Flood control canals and by-passes
  - F2150 Intermittent tributaries flowing into reservoirs
  - F2160 Intermittent tributaries flowing into regulated streams
  - F2170 Intermittent tributaries flowing into unregulated streams

F2200 **Permanent Waters**

- F2210 Perennial tributaries flowing into reservoirs
- F2220 Perennial tributaries flowing out of reservoirs
  - F2221 Non tidally influenced
  - F2222 Tidally influenced
- F2230 Regulated channel with small ponds and diversions
  - F2231 Non tidally influenced
  - F2232 Tidally influenced
- F2240 Regulated channel (by reservoir on adjacent tributary)
- F2250 Perennial tributaries flowing into regulated streams
- F2260 Perennial tributaries flowing into unregulated streams

APPENDIX C
CULTURAL RESOURCES REGULATIONS

FEDERAL REGULATORY FRAMEWORK

The National Historic Preservation Act of 1966 requires federal agencies to consider the preservation of historic and prehistoric resources. The Act authorizes the Secretary of the Interior to expand and maintain a National Register of Historic Places (NRHP), and it establishes an Advisory Council on Historic Preservation (ACHP) as an independent federal entity. Section 106 of the Act required federal agencies to take into account the effects of their undertakings on historic properties and afford the ACHP a reasonable opportunity to comment on the undertaking prior to licensing or approving the expenditure of funds on any undertaking that may affect properties listed, or eligible for listing, in the NRHP.

The National Environmental Policy Act of 1969 requires federal agencies to foster environmental quality and preservation. Section 101(b)(4) of the statute declares that one objective of the environmental policy is to "preserve important historic, cultural, and natural aspects of our national heritage...." For any major federal actions significantly affecting environmental quality, federal agencies must prepare and make available for public comment an environmental impact statement (EIS).

The Historic and Archaeological Data Preservation Act of 1974 covers the preservation of historic and archaeological data that would otherwise be lost as a result of federal construction or other federally licensed or assisted activities. When federal agencies find that their undertakings may damage archaeological resources, the agencies may use a portion of their project funds to pursue recovery, protection and preservation of the jeopardized resources and data, or they may require assistance from the Secretary of the Interior to undertake preservation measures.

The American Indian Religious Freedom Act of 1978 declares that "it shall be the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indians..., including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonial and traditional rites." Advisory Council Regulation, Protection of Historic Properties, October 1, 1986 (36CFR800) established procedures for compliance with the cited statutes (supra), particularly Section 106 of the National Historic Preservation Act of 1966. As well, these regulations define the Criteria of Effect and Criteria of Adverse Effect (800.5), stipulate procedures for affording the Council an opportunity to comment (800.6), define the role of the State Historic Preservation Officer (SHPO) in the Section 106 review process (800.7), set

STATE REGULATORY FRAMEWORK

In addition to the NRHP criteria for evaluation, the California Environmental Quality Act (CEQA) Statutes and Guidelines define an important cultural resource as one which:

A. is associated with an event or person of:

    1. recognized significance in California or American history, or
    2. recognized scientific importance in prehistory;

B. can provide information which is both of demonstrable public interest and useful in addressing scientifically consequential and reasonable or archaeological research questions;

C. has a special or particular quality such as oldest, best example, largest or last surviving example of its kind;

D. is at least 100 years old and possesses substantial stratigraphic integrity; or

E. involves important research questions that historical research has shown can be answered only with archaeological methods.

Thus, a cultural resource is considered important if it can yield information to address significant research questions and is the principal source of this information. Important archaeological resources must be considered in the CEQA environmental review process. Resources deemed unimportant need not be so considered. In cases where both the CEQA and NRHP evaluation criteria apply, federal standards prevail. Historic properties assessed as NRHP-eligible are also considered important, and procedures for managing these properties under 36CFR800 satisfy the CEQA *Statutes and Guidelines* as well.

APPENDIX D
LIST OF REPORT PREPARERS

LIST OF REPORT PREPARERS

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Appendix A-5

Alameda Creek Water Resources Study
January 1995

7

ALAMEDA CREEK
WATER RESOURCES STUDY

PREPARED FOR

SAN FRANCISCO WATER DEPARTMENT

PREPARED BY

BOOKMAN-EDMONSTON
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APPENDICES

SECTION 1 INTRODUCTION

Since the City and County of San Francisco purchased the Spring Valley Water Company (SVWC) in 1930, the San Francisco Water Department (SFWD) has operated a large water supply system in the Alameda Creek watershed which is collectively known as its Alameda Division. The water management features of this watershed, located in Alameda County between Fremont and Pleasanton, are shown in Figure 1-1.

SFWD initiated a study of the Alameda Creek watershed in August 1992. Bookman-Edmonston Engineering, Inc. (B-E) was selected as a consultant to conduct this study with the assistance of BioSystems Analysis, Inc., Luhdorff and Scalmanini Consulting Engineers, Ogden Environmental and Energy Services, and Olivia Chen Consultants. This report presents the results of the Alameda Creek Watershed Study. This chapter begins by providing background on the study needs and objectives and also includes a discussion of the closely related San Francisco Watershed Management Study.

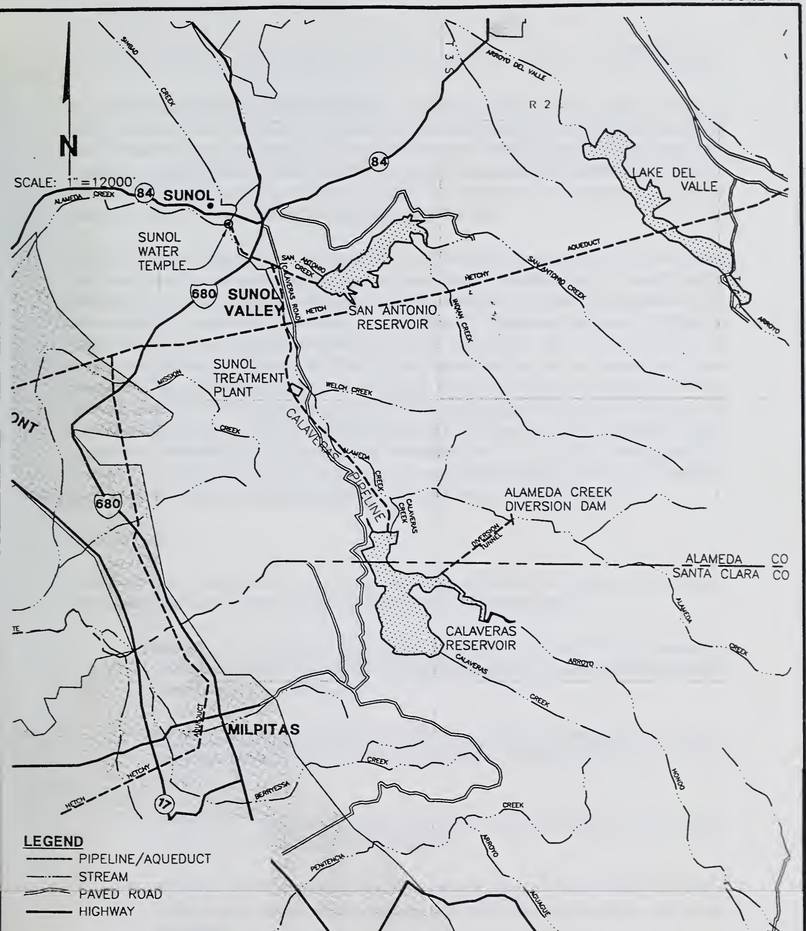
BACKGROUND

Currently, the San Francisco water system collects surface runoff in the watershed behind Calaveras and San Antonio Reservoirs. Calaveras Reservoir captures and stores the majority of the considerable runoff from the Calaveras and Upper Alameda Creek watersheds (see Figure 5-2). San Antonio Reservoir captures the small amount of runoff from the San Antonio watershed, but it principally provides "off-stream" storage for the Hetch Hetchy Aqueduct and, at times, the South Bay Aqueduct. In addition to surface water regulation in the Sunol Valley, some groundwater is also collected in the Sunol Infiltration Gallery. Water collected or stored in Calaveras and San Antonio Reservoirs and collected at the Sunol Infiltration Gallery is delivered through closed pipelines to the Sunol Treatment Plant for treatment and subsequent delivery to SFWD's customers.

Because of the intensity of water management in the Alameda Creek watershed, only small amounts of streamflow are found in the natural watercourses. In normal years, the great majority of flow is stored in Calaveras Reservoir. The only flow remaining in the stream channel in normal years is runoff directly from the lower, drier portion of the watershed and seepage from Calaveras Reservoir and from geologic formations. This flow amounts to about 0.5 cubic feet per second (cfs) in that portion of Calaveras Creek immediately below Calaveras Reservoir.

With the low flows available in Calaveras and Alameda Creeks, fishery conditions are favorable to support only small fish populations. The interest of conservation and fisheries agencies and organizations in enhancing Alameda Creek fisheries has caused SFWD to review the possibility of changed operation of the Alameda Creek System. One

FIGURE 1-1



ALAMEDA CREEK WATER RESOURCES STUDY

PROJECT AREA

SAN FRANCISCO WATER DEPARTMENT

opportunity for revised operation would be to release a portion of water supply deliveries from Calaveras Reservoir directly into Calaveras and Alameda Creeks. Flows released into the streambed in this manner could provide improved fisheries and riparian vegetation conditions while still being used for SFWD supply, if recaptured at a downstream location. The change in operations would provide improved fisheries at the expense of increased energy usage and cost resulting from additional pumpage.

In reviewing the possibility for reoperation of SFWD's Alameda Creek facilities, one option for recapturing streamflows is the use of groundwater aquifers in the Sunol Valley. Potentially, such groundwater use could involve renovation of the Sunol Infiltration Gallery. Alternatively, groundwater use could be developed by replacing the Sunol Infiltration Gallery with modern wellfield or collection system technology. In any case, recapture of water from fisheries releases in the Sunol Valley would be affected by existing land uses there, especially gravel mining and nursery operations. Gravel operations in Sunol Valley have removed a large quantity of the valley's alluvium and significantly affected surface and groundwater flow and groundwater storage potential. Wholesale nursery operations, while significantly less intrusive on groundwater conditions than that of gravel mining, have the potential for adversely affecting the quality of groundwater through the use of chemicals such as pesticides and fertilizers, especially in areas close to stream courses.

OBJECTIVES

Considering the background of the Alameda Creek watershed described above, several objectives have been defined for the Alameda Creek Watershed Study:

- Identify the potential for establishing fisheries above Sunol Valley considering biological requirements, riparian vegetation conditions, recapture feasibility, and institutional responsibilities.

- Identify the potential for Sunol Valley groundwater management–including recharge, storage, and extraction–to increase overall SFWD yield of water supply.

- Recommend reservoir operation policies to assure adequate water quality conditions and maximize water supply.

- Develop recommendations for the beneficial uses of Sunol Valley including water supply, gravel mining, nursery use, water treatment facilities, and public recreation.

WATERSHED MANAGEMENT PLAN

Concurrently with the Alameda Creek Watershed Study, SFWD is also developing Watershed Management Plans for both the Peninsula and Alameda watersheds. Development of these Watershed Management Plans will be a multiyear process involving considerable public involvement and environmental documentation in addition to technical studies. The Watershed Management Plans will provide policy to SFWD in managing land use within lands owned by SFWD. The primary goal defined for the Watershed Management Plan is to "Maintain and improve water quality to protect public health and safety." Secondary goals of the Watershed Management Plan include considerations of water supply and ecological enhancement, financial impacts, and fire protection, among others. These plans will be completed in late 1996. ✓

Because of the broad goals of the Watershed Management Plans, all the elements of the Alameda Creek Watershed Study will be affected. Consequently, close coordination was maintained between the studies. The recommendations of the Alameda Creek Water Resources Study have been developed considering the broad goals of the future Watershed Management Plans. However, some of the recommendations included in this study should be considered provisional pending inclusion in the Watershed Management Plan. good

REPORT ORGANIZATION

This report begins with a Findings, Conclusions, and Recommendations section that summarizes overall study results. Individual sections are then presented that summarize study activities for the specific topics of fisheries, groundwater, water supply operations, gravel extraction, other beneficial uses, and facilities. In addition to the summary descriptions included in this report, a separately bound second volume was prepared that contains detailed topic reports that contributed to the overall study.

SECTION 2 FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

FINDINGS

1. The existing Alameda Creek fishery contains an assemblage of native, predominantly warm water fish, including Sacramento sucker, Sacramento squawfish, California roach, and threespine stickleback. Alameda Creek also contains small populations of native, cold water species, such as Pacific lamprey and rainbow trout. The Environmental Protection Agency is considering declaring portions of the Alameda Creek watershed an Aquatic Diversity Management Area based on its native fishery.

2. Although steelhead trout historically spawned in the Alameda Creek watershed, they ceased spawning by the 1950s, and several physical structures downstream of the study area currently impede their potential migration path.

3. Comparison of surface water quality samples--tested for water temperature, dissolved oxygen, pH, hydrogen sulfide, copper, iron, and manganese--with Environmental Protection Agency (EPA) standards revealed that all water quality parameters are within acceptable limits. No water quality conditions were observed that would preclude establishment of a trout population.

4. Riparian vegetation conditions in portions of Alameda Creek and Calaveras Creek above the Sunol Treatment Plant are generally favorable, although algae mats and disturbed soil conditions at some locations adversely affect stream conditions for fish.

5. In Sunol Valley, riparian vegetation conditions are sparse beginning just downstream of the Sunol Treatment Plant and continuing to just upstream of the Sunol Water Temple. Comparison of current conditions with 1912 pre-project photographs of the site illustrate that this is a continuation of natural conditions. Low summer surface flows typically have been absorbed as recharge into the groundwater basin.

6. The Sunol Valley groundwater basin is a combination of two distinct types of alluvial deposits. The upper 50 feet of the basin consist of extremely coarse alluvial sand and gravel deposits of high permeability. The portion of the Sunol groundwater basin below 50 feet consists primarily of the Livermore gravel formation, which is cemented and has low permeability.

7. Gravel operations in the Sunol Valley have removed a significant portion of the shallow alluvium, which is no longer available for water supply purposes. The gravel operations have provided several million dollars of revenue to the SFWD.

8. Limited groundwater quality sampling indicated that groundwater in the Sunol Valley is of a calcium-magnesium bicarbonate type. Concentrations of total dissolved solids (TDS) typically range from about 350 to 500 mg/l, although several sites had considerably higher concentrations. Although the TDS concentrations are generally lower than the secondary maximum contaminant level of 500 mg/l, they are considerably higher than SFWD's Hetch Hetchy Aqueduct supplies, which average 40 mg/l. Blending of groundwater supplies with surface water supplies results in high er quality water.

9. Nursery operations in the Sunol Valley are estimated to use about 380 acre-feet (AF) of water annually. The nurseries in Sunol Valley tightly manage their water use, primarily relying on drip irrigation, which results in minimal potential for groundwater contamination from fertilizer.

10. The Alameda Creek watershed provides flows derived predominantly from rainfall runoff. In normal years, streamflows peak during the winter and spring rainfall season. During summer and early fall, flows are insignificant. The flow available from the Alameda Creek watershed also varies considerably from year to year, with minimal flows occurring during many low rainfall years.

11. Historically, SFWD has operated the 100,000 AF capacity Calaveras Reservoir to regulate Calaveras Creek, Arroyo Hondo, and Alameda Creek flows to provide potable supplies. More recently, SFWD has operated San Antonio Reservoir (with 50,438 AF capacity) to regulate a combination of local runoff; Hetch Hetchy, South Bay Aqueduct and Calaveras Reservoir surplus flows; and small quantities of subsurface flow recovered by the infiltration galleries at the Sunol Water Temple.

12. Based on an operation study of the Alameda Creek watershed, the water supply provided to SFWD by the watershed averages about 59,700 AF per year. The dependable supply from Alameda Creek in drought years falls to about 12,000 AF per year.

13. The Sunol Infiltration Gallery historically supplied large amounts of water prior to interruption of its primary supply when a portion of the supply was changed to direct diversions from Calaveras Pipeline and cessation of Pleasanton well field pumping. Seasonal surface flows are still diverted from Alameda Creek through the Gallery to the Sunol Pump Station, where water is then pumped to San Antonio Reservoir. The Infiltration Gallery will require physical renovations to resume its original function.

14. From 1916 to 1934, flows were released from Calaveras Reservoir to Alameda Creek and diverted downstream at the Sunol Infiltration Gallery. Since 1934, SFWD has directly extracted water from Calaveras Reservoir through the Calaveras Pipeline

resulting in no significant flows directly below the dam except for spill periods, which occur, on average, every five to six years.

15. Facilities could be constructed that would recapture planned releases of Calaveras Reservoir at downstream sites in the Sunol Valley. Properly designed facilities could recapture a volume of water equal to that released for fishery enhancement.

CONCLUSIONS

1. Based on a habitat analysis and stream temperature modeling, habitat conditions in Alameda Creek are suitable for establishment of a trout fishery in the portion of the creek generally upstream of the Sunol Treatment Plant. The primary requirements for improving the fisheries are summer stream temperatures and early spring spawning flows.

2. Establishment of a trout fishery between Calaveras Dam and the Sunol Treatment Plant could adversely affect the existing native fishery in that reach.

3. A preferred fisheries flow management plan (Alterative 4 described on page 3-18) was identified that provides for a balance between enhanced trout fisheries and maintenance of native nongame fisheries. The preferred plan for flow management below the confluence of Alameda and Calaveras Creeks would provide the following range of flows:

Period	5-Day Running Average	Minimum Daily
November 1 - January 31	5 cfs	4.5 cfs
February 1 - March 31	20 cfs	18 cfs
April 1 - October 31	7 cfs	6.3 cfs

A minimum flow of 5 cfs should be maintained in Calaveras Creek above its confluence with Alameda Creek during February and March. This plan received the endorsement of the California Department of Fish and Game (CDFG) by letter dated October 19, 1994 [see Appendix I, *Letter from the State of California Department of Fish and Game Recommending Implementation of Alternative 4 (Protection and Enhancement of Native Rainbow Trout and Non-Game Fishes) as Identified in the Alameda Creek Watershed Study, Fishery Restoration Feasibility Evaluation and Preliminary Restoration Plan, November 1993 (Appendix E)*].

4. A variable portion of the fisheries flows would be supplied by unregulated runoff from Alameda Creek. The maximum 12-month potential release from storage would be about 6,200 AF, if there is no contribution from Alameda Creek.

[illegible]

5. If it is necessary, release schedules should be adjusted such that not less than 30,000 AF remain in Calaveras Reservoir through late summer and October to provide cold water for instream releases.

6. Establishment of a trout fishery below the Sunol Treatment Plant would not be feasible because of permeable streambed conditions, which could intercept fisheries flows, and naturally sparse riparian vegetation that would result in unsuitable warm stream temperatures.

7. Riparian habitat conditions within the project area and throughout Alameda Creek could be improved through streamside fencing to prevent cattle from entering and causing deterioration of the riparian stream zone.

8. Groundwater development for water supply purposes, including the Sunol Infiltration Gallery operation, is not feasible. The upper, shallow alluvium is too thin, and significant areas of the shallow alluvium have been physically removed by gravel development. The underlying Livermore Gravels are cemented and have permeability values that are too low to permit significant development.

9. The gravel quarries being excavated in Sunol Valley have resulted in relatively large volumes of excavated area that could be developed for storage of surface flows. Completion of presently permitted mining could provide 26,880 AF of additional surface water storage. Water storage potential could be increased to 79,450 AF through continuation and expansion of gravel quarries in Sunol Valley. Ultimate use of the reclaimed gravel quarries for water storage could be enhanced through gravel management policies that minimize the volume of fines returned to excavated pits on SFWD-leased lands and accelerate completion of quarry operations to allow water storage development.

10. Earlier completion of the existing quarrying operations through deepening of pits would result in an enhancement of the City's water supply, whereas allowing expansion of existing quarries would defer use of the pits for water storage.

11. When gravel quarries operations are completed, relatively minimal facilities would be required to convert the reclaimed quarries for surface storage usage. Based on an appraisal-level analysis, the costs of facilities required to develop 44,750 AF of quarry reservoir storage would be $20.5 million.

12. An evaluation of facilities alternatives concluded that the best water recapture alternative would be a surface impoundment just downstream of the Sunol Filtration Plant with recovery through either streamside pumps or an infiltration gallery. These facilities have an estimated cost of $6.2 million. The annual costs for energy consumption at these facilities are estimated as $138,400.

RECOMMENDATIONS

1. Based on the October 19, 1994 letter received from CDFG, the SFWD should formalize an agreement regarding objective flows, operating conditions, monitoring requirements, and respective obligations. The total cost of reaching an agreement with CDFG will be dependent upon the duration of negotiations. The cost of preparing a draft Memorandum of Understanding to initiate the process, however, is estimated at $10,000.

2. The SFWD should prepare a definite plan report on the flow recapture facilities and their operation, including a geotechnical investigation of foundation conditions at alternative sites for a rubber dam, sizing of project features, an initial environmental evaluation, operation requirements, and capital and annual cost estimates. The cost of preparing a definite plan report is estimated at $45,000.

3. The SFWD should develop an Integrated Resources Management Plan (IRMP) for Sunol Valley and its other resources in the East Bay area. Conceptually, an IRMP would help SFWD maximize the revenue-generating potential in the Sunol Valley while simultaneously protecting the watershed and facilitating establishment of a trout fishery. The IRMP would assist SFWD in administering the gravel quarry leases, in converting abandoned quarries to surface water storage reservoirs, and in administering the fisheries program. NB REINFORCE

SECTION 3 FISHERIES

Many tributaries of San Francisco Bay, including Alameda Creek, once supported native populations of rainbow trout (*Oncorhynchus mykiss*) as well as its anadromous form, steelhead (Skinner 1962). Due to rapid urban development, loss of riparian habitat, water diversion, introduction of nonnative species, and creation of migration barriers, some of these trout populations have decreased. Recent droughts have also contributed to their demise. While some trout habitat is still available in many of these streams, a lack of water hinders migration and spawning attempts by this species and limits instream habitat, even in streams with no barriers.

For many of the same reasons, populations of nongame native fish have also declined. In the past, resource agencies have, in some areas, made concerted efforts to eliminate native nongame fish (i.e., poisoning, selective removal) to decrease competition and predation of game fish. The approach of resource agencies to the management of native nongame fish, however, has changed considerably in recent years. Maintaining biodiversity has now become an important objective of resource management. This change in philosophy has resulted in a higher value being placed on all native fish, regardless of their sport value.

Flows in Calaveras and Alameda Creeks have been regulated since 1916, when the release gates were installed on the partially completed Calaveras Dam. In an attempt to improve water resource utilization, the SFWD is exploring the possibility of increasing releases from Calaveras Reservoir for recapture downstream. With increased flows, Calaveras and Alameda Creeks may have the potential to once again support trout populations. Increased flow could also be used to improve habitat conditions for the current assemblage of native nongame fish residing in the stream.

BACKGROUND

One of the earliest reports of fish populations in the Alameda Creek watershed documented the occurrence of six native species, including California roach, hitch, Sacramento squawfish, Sacramento sucker, tule perch, and prickly sculpin. Aceituno et al. (1976) reviewed other early collections and concluded that at least five and possibly six additional species were native to the watershed. These include rainbow trout, Sacramento blackfish, threespine stickleback, riffle sculpin, and Pacific lamprey. Sacramento perch have been collected in Alameda Creek, but their presence is believed to be the result of an introduction to Calaveras Reservoir.

Rainbow trout have been documented above Calaveras Reservoir on several occasions between 1905 and more recent times. This is probably a landlocked population derived from a coastal steelhead stock that was isolated in the upper part of the drainage by natural process or by the construction of Calaveras Dam between 1913 and 1925. Rainbow trout

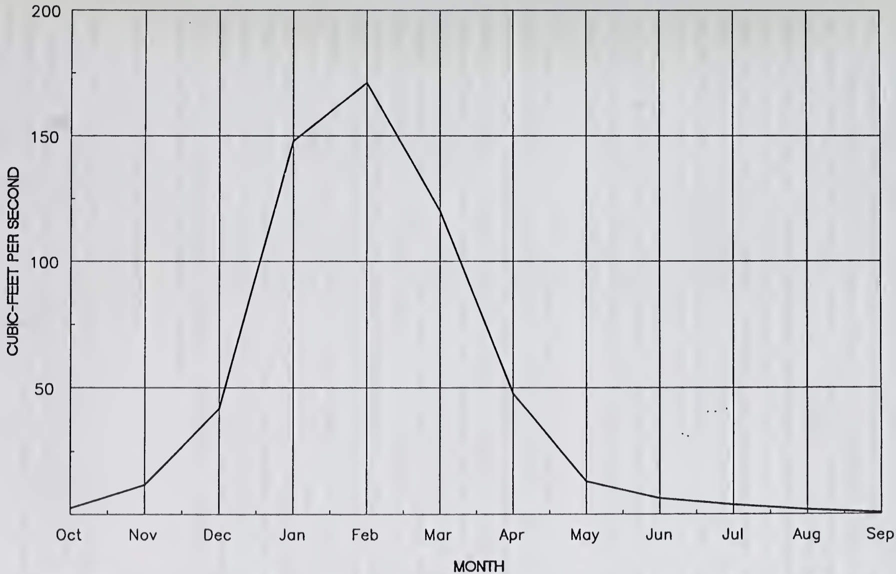
have also been collected below Calaveras Dam in several surveys in the 1970s and 1980s. Recent field studies by the Environmental Protection Agency have confirmed the presence of healthy resident trout populations in two areas of the Alameda Creek watershed: one immediately upstream of the confluence of Alameda and Calaveras Creeks in the Little Yosemite area and one above the Alameda Creek Diversion Dam. These trout are probably the result of spawning by resident stream fish, since there are several barriers to migration of steelhead in Niles Canyon and below.

The CDFG maintains that historically Alameda Creek was a steelhead stream, but that, as a result of water development and urbanization within the drainage and loss or degradation of steelhead spawning and rearing habitat, self-sustaining steelhead likely ceased to exist within the drainage by the late 1950s. No records of spawning run counts or estimates of the steelhead population size in Alameda Creek were found in CDFG files in Los Gatos. CDFG stocked Alameda Creek in Niles Canyon with catchable rainbow trout until 1993, when uncontrolled public access frustrated stocking activities.

Hydrologic and Water Quality Conditions

Hydrologic conditions within the Calaveras Creek and Alameda Creek watersheds have defined habitat conditions for trout and native nongame species in the past and will ultimately determine the amount of water available for improving habitat conditions for fish below Calaveras Dam. The seasonal hydrologic patterns of Alameda Creek are typical of central California coastal streams. The U. S. Geological Survey (USGS) collected streamflow data at Arroyo Hondo (the primary source of inflow to Calaveras Reservoir) from 1969 to 1981. Streamflows peak in January, February, and March and decline to extremely low levels during the summer months (June-October) (Figure 3-1). Historically, flow below Calaveras Reservoir would have included runoff and some seepage from the valley now containing the reservoir, as well as flow from Alameda Creek, which joins the Calaveras tributary a short distance below Calaveras Dam. Flood flows in Alameda Creek are presently diverted to Calaveras Reservoir at the Alameda Creek Diversion Dam.

Water quality, especially water temperature, in Calaveras Reservoir is of critical importance to development of a rainbow trout population in the creek. Reservoir releases must be cold to support trout populations, since they are most healthy at temperatures below 64°F. Other native fish in the stream prefer higher summer water temperatures. Since water released from the reservoir warms as it moves downstream, the release temperature must be cold during the summer period to support trout. Reservoir releases must also be free of substances harmful to fish and other aquatic life.



ALAMEDA CREEK WATER RESOURCES STUDY

ARROYO HONDO INFLOW TO CALAVERAS RESERVOIR

AVERAGE MONTHLY FLOW (1969-1981)

SAN FRANCISCO WATER DEPARTMENT

[illegible]

[illegible]

[illegible]

The SFWD regularly collects data on reservoir water quality. Water temperature profiles were available for 1985, 1989, and 1990, and for the fall months of 1984, 1987, and 1988. The water temperature profile of Calaveras Reservoir is generally isothermal in winter (November through March), ranging between 45.5° and 52°F. Release temperatures during this period will be suitable for downstream trout populations. Thermal stratification in the reservoir typically begins in March; the reservoir becomes fully stratified by the end of April with a warm surface layer and a colder bottom layer. The reservoir remains fully stratified until late October. While the reservoir is stratified, the temperature of the warm surface layer typically ranges between 59° and 77°F. During stratification, the transitional area between the surface layer and the bottom layer is generally 20 to 40 feet below the water surface. The upper boundary of the bottom layer ranges between 46° and 54°F, but it can be warmer in years of low storage. In October, the upper layer begins to cool and mixes to a greater depth, descending to a depth of 40 to 50 feet below the surface. This is the time of year when the reservoir releases are likely to be at their warmest; therefore, it is a critical period for downstream trout populations.

The dissolved oxygen profile of Calaveras Reservoir is also related to depth. In winter, when the reservoir is not stratified, dissolved oxygen levels are at their highest, ranging between 7.5 and 12 milligrams per liter (mg/l) throughout the water column. During stratification, oxygen is absorbed from the atmosphere, produced in the upper layer by photosynthesis of algae and aquatic plants, and consumed in the lower layer by decay processes. Dissolved oxygen levels are near saturation in the upper layer during this period, ranging between 8 and 11 mg/l. In the lower layer, dissolved oxygen levels stay above anoxic conditions (>1.0 mg/l) for approximately two months following thermal stratification; however, after this point, dissolved oxygen levels drop below 1.0 mg/l. These conditions remain until destratification begins and the reservoir becomes isothermal by mid- to late-December. Although reservoir releases are oxygenated rapidly after they pass through the release valve, dissolved oxygen in the reservoir is important because of its effect on other water quality parameters. When oxygen is depleted in the hypolimnion, hydrogen sulfide concentrations can build to levels toxic to fish. Also, low dissolved oxygen levels create a chemical environment in which any heavy metals that may occur in reservoir sediments are moved into solution in the water column. SFWD installed reservoir aerating facilities in 1992 to prevent heavy metals from dissolving. The aerator is designed to aerate the reservoir while preserving stratification conditions.

Bay Area Trout Restoration Projects

Many local, state, and federal agencies, as well as private entities, are becoming more involved in trout habitat improvements projects throughout California. The overall decline of salmonids, especially anadromous populations, has prompted this interest. Several projects are currently under way to improve conditions for salmonid migration, spawning, rearing, and holding.

In the Central Coast and San Francisco Bay area, CDFG is involved in several habitat restoration projects. In Wildcat Creek in Contra Costa County, several measures are being implemented to help restore steelhead trout populations, including creation of scour pools for summer holding habitat, restoration of riparian areas, and removal of fish passage barriers. Wildcat Creek was stocked with individuals from a landlocked strain of coastal steelhead from Redwood Creek, a tributary of the San Leandro Reservoir, also in the East Bay Hills. A habitat restoration plan for rainbow trout has been designed but not yet implemented for Walnut Creek in Central Contra Costa County. Other creeks undergoing similar habitat restoration for salmonids include Pescadero and San Pedro Creeks in San Mateo County and Gazos Creek in Santa Cruz County.

A few streams in the East Bay Hills currently support rainbow trout populations under natural streamflow conditions, despite recent drought conditions. Tributaries of the upper San Leandro Reservoir, including Redwood and San Leandro Creeks, have supported spawning runs of rainbow trout out of the reservoir since the completion of Chabot Dam early in this century.

HABITAT ASSESSMENT

There are several technical approaches for quantifying potential fish habitat at different levels of flow. These include the Instream Flow Incremental Methodology (IFIM) and the Stream Network Temperature Model (SNTEMP). The IFIM, developed by the U. S. Fish and Wildlife Service (USFWS) determines habitat and streamflow relationships for juvenile and adult life stages of the species of concern. SNTEMP predicts instream water temperature based on stream geometry, meteorological, and hydrological conditions. Both SNTEMP and IFIM are data-intensive and costly, and require monitoring data under varying flow conditions.

The IFIM is often used to establish flow recommendations for fisheries management. The IFIM indexes habitat conditions (i.e., water depth, flow velocity, and substrate) under a range of flows to determine suitability for fish. Species suitability criteria for rainbow trout can be obtained from either published sources or from information developed on the specific populations of interest or similarly populations. With the IFIM, potential flow alternatives can be better examined, and a more precise relationship between flow and trout habitat can be determined.

The SNTEMP model, also developed by the USFWS, solves heat transfer equations to predict instream water temperatures based on historical or synthetic hydrological, meteorological, and stream geometry conditions. The steam network consists of a series of reaches connected by nodes. Each node represents a location where either a change occurs in the stream or where model output is required. Changes in the stream include dams, tributaries, confluences, and diversion; stream geometry data include azimuth, elevation, latitude, width, and shading. SNTEMP can predict water temperatures at any point in the network.

Since the primary objective of the fisheries study was to determine whether flow at some level would provide habitat conditions for trout, rather than determining the optimum level of flow for maintaining trout, a full IFIM study was not conducted. Instead, reliance was placed on observations and data collected during experimental releases of flow from Calaveras Reservoir. Micro-habitat data (depth, velocity, and substrate) were collected at several stream transects to determine whether suitable conditions for trout would occur at the flow levels observed, and the extent of different macro-habitat types (riffles, pools, etc.) were mapped. A SNTEMP model was then developed and calibrated from a limited set of monitoring data collected between July and November of 1992.

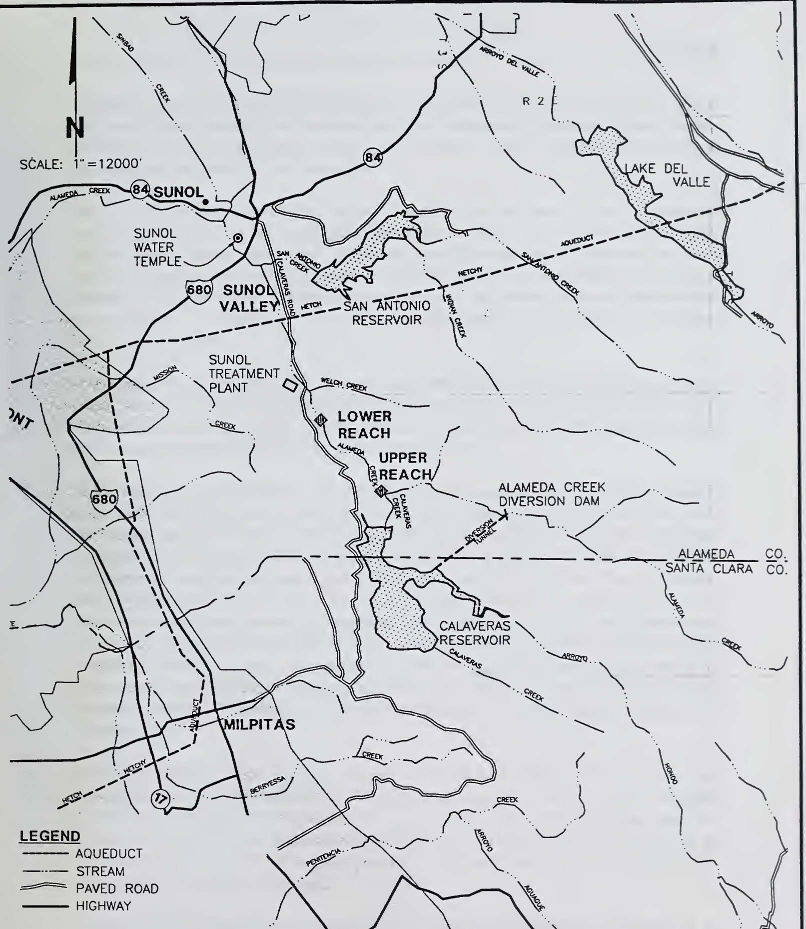
Experimental flow releases were made from Calaveras Reservoir by SFWD between September 28 and October 1, 1992. Experimental flows were 30 cfs on September 29, 10 cfs on September 30, and 5 cfs on October 1. Habitat conditions were recorded in two experimental reaches; water quality data were collected near the release point and at two downstream locations; and stream temperature and meteorological conditions were monitored during the late summer and fall, including the experimental flow release period. The stream temperature and meteorological data were used to calibrate the SNTEMP model for predicting stream temperatures. Although this is a very small database for developing an accurate stream temperature model, the SNTEMP model was the best tool for evaluating stream temperature under the conditions and requirements of the study.

At the time of the experimental releases, the water surface elevation of Calaveras Reservoir was 699 feet above sea level. Storage capacity at this level is about 36,000 AF. Water was withdrawn from the reservoir's lower layer. Estimated temperature at the withdrawal depth was between 55°and 67°F, and the average lower layer temperature was 54°F. Based on this information, release water was being drawn from the top of the lower layer, or from within the interface between the upper and lower layers.

Instream Habitat

On August 2, 1992, biologists walked the length of Calaveras Creek from below Calaveras Reservoir to its confluence with Alameda Creek and downstream from there to the Calaveras Road bridge. Based on visual evaluation of stream channel morphology and habitat types, two reaches (upper and lower) were selected as representative study areas for future instream studies (Figure 3-2). The upper site had a slightly higher gradient, the stream was narrower and more confined, and the riparian vegetation was well developed and relatively undisturbed. The lower site was characterized by slightly lower gradients, the stream was relatively broad and unconfined, and the riparian vegetation had been modified by cattle grazing.

The approach to evaluating the potential for Alameda Creek to support trout populations was twofold. Both approaches included examining stream habitat under different flow



ALAMEDA CREEK WATER RESOURCES STUDY

FISHERIES FIELD SURVEY LOCATIONS

SAN FRANCISCO WATER DEPARTMENT

conditions. First, the composition of aquatic macro-habitat types (riffle, pool, etc.) within each reach during each day of experimental flow release was measured. Second, micro-habitats, such as water depth, velocity, and substrate, were measured across several representative transects within each reach.

Prior to the experimental release, several transect locations were chosen to represent spawning, pool, head of pool, and riffle habitat types. Within each reach, a total of eight transects were selected and marked. In general, runs dominate aquatic habitat in the upper reach of Alameda Creek, while a more balanced composition of runs, riffles, and pools is present in the lower reach. Habitat types did not vary significantly between experimental release periods in either reach. More trout spawning habitat was available at the higher flows in both reaches.

In the upper reach, a high pool-to-riffle ratio was observed during all flow release periods, while the lower reach had a pool-to-riffle ratio closer to one. Optimal river rainbow trout habitat is characterized by a 1:1 pool-to-riffle ratio. A similar index has not been developed for evaluating habitat conditions for native nongame fish.

Depth and velocity data collected for the transects were used to develop habitat suitability index (HSI) scores for four different trout life stages: spawning, fry, juvenile, and adult. The highest attainable HSI score of 1.0 is indicative of optimal depth and velocity conditions for a given trout life stage. HSI scores of 0 indicate unsuitable, or little available habitat, and scores intermediate between 0 and 1.0 indicate average habitat conditions. In general, areas of high suitability occurred in portions of all transects, but averaging all parts of the transects obscured the presence of these ideal areas. Depth and velocity were measured at several cells within each transect and used to compute an HSI index that was then averaged over all the cells in a transect. A complete summary of the HSI scores for each life stage for each transect are included in the complete fisheries report in Appendix E, *Alameda Creek Watershed Study, Fishery Restoration Feasibility Evaluation and Preliminary Restoration Plan, November 1993.*

The HSI scores for spawning were highest at 30 cfs but tapered off at lower flows. Conversely, the HSI indicated that suitable depth and velocity occurred for other life stages at all flows in both reaches. Flows of 5 cfs appeared to result in slightly higher scores for fry and juvenile than those observed at higher flows. For adults, the HSI scores indicate that flows equal to 30 cfs are slightly preferable. Overall, the differences in HSI scores between flows were generally small.

Optimal stream substrate size for spawning of rainbow trout less than 20 inches and for embryo incubation ranges from about 0.6 to 2.4 inches. Measurements of substrate composition across each transect indicated that suitable substrate was present in many of the transects. Coarse gravel that is especially suitable for trout spawning dominated substrate type in three transects in the lower reach.

Water Temperature Model Development

SNTEMP Data Preparation

The stream temperature model, SNTEMP, uses six input data files: stream geometry data (channel width, elevation, etc.); time period information (temporal specification of the model); meteorological information (air temperature, wind speed, etc.); study node information (desired temperature output location); hydrology node data (location of observed flows); and hydrology data (flow and water temperature data) at the hydrology nodes. A shade data file is optional.

The stream geometry data were obtained from three sources: USGS topographical maps; aerial photographs taken on March 27, 1992; and measured transect data from BioSystems' field work. The model uses a daily time step and covers the dates from August 1 through October 1, 1992. The model's geographical starting point was approximately 1,000 feet downstream of Calaveras Dam, and the end point was approximately 8.8 miles downstream at the Sunol Water Temple.

BioSystems' weather station, placed near Calaveras Dam, provided the meteorological data for the water temperature model between July 31 and November 13, 1992. The meteorological station included datapods for recording air temperature, relative humidity, solar radiation, and wind speed. All datapods were programmed to record at 120-minute intervals.

Water temperature in both Calaveras and Alameda Creeks was monitored with datapods between July and November 1992 at four locations. This provided the temperature data required for the SNTEMP model calibration. The datapods were programmed to record water temperature at 120-minute intervals. The most upstream datapod, also the beginning point of the model, was placed approximately 1,000 feet downstream of the Calaveras Dam (Figure 3-1). A second datapod was placed approximately 1,500 feet downstream of the confluence of Alameda and Calaveras Creeks. The third datapod was placed approximately 2,950 feet upstream of the Sunol Treatment Plant. The most downstream datapod was placed adjacent to the Sunol Treatment Plant.

Since no measured flow data were available for the entire calibration period, a flow estimate of 0.5 cfs was used for periods when no flow was released from Calaveras Reservoir (August 1 through September 28, 1992). This estimate was based on observations during initial reconnaissance of the stream in August. During experimental releases between September 29 and October 1, flow was estimated in the upper and lower reaches from water velocity data collected at BioSystems' transects. The measured data were used in the model for those three days.

Only topographical shade data were used in the shade data file. Although percent shade is a moderately sensitive parameter of SNTEMP, vegetative shade is an optional module of the SNTEMP model. Because of the high cost of collecting the detailed data needed, the use of the shade parameter is recommended only when a stream project includes alteration of stream shading as an explicit or implicit management option. Data collected in the baseline riparian habitat assessment could not be fully incorporated into the model because of budget constraints. The impact on model calibration in this case appears to be fairly small since the model does not consistently overestimate water temperatures. Other parameters were altered in the calibration procedure that compensated for the omission of shade data.

SNTEMP Model Calibration

Calibration is the process of fine-tuning the model to simulate the system's natural dynamics as closely as possible. After compiling the data into appropriate input data format, model runs are made to calibrate the predicted with observed water temperature data. The SNTEMP model was calibrated by adjusting constants and coefficients that apply to each of the meteorological variables: air temperature, wind speed, relative humidity, percentage of sunshine, and solar radiation.

The SNTEMP model for Calaveras and Alameda Creeks was calibrated for the time period between August 1 and October 1, 1992, a total of 62 days, which included the experimental release periods. Actual monitoring values for each day during this period were used as input data. The calibration node was located approximately 80 feet downstream of the confluence of Alameda and Calaveras Creeks. The final calibration run resulted in a mean difference between observed and predicted water temperature of -0.2°F. The maximum difference was 3.2°F, and the minimum difference was -3.9°F. Although a closer fit could probably be obtained with more extensive calibration data, the fit appears adequate for the purpose of this study (i.e., for a feasibility assessment).

Verification

The model was verified by using the calibrated model with a different set of temperature data, either at the calibration node or at a different location in the stream. This provides a means for testing the model's performance in a condition other than the calibration condition. The temperature data from the datapod located 2,950 feet upstream of the Sunol Treatment Plant was used to test the calibrated model's performance. Verification runs are executed in the same way as the calibration runs but using a different data set.

The verification model run resulted in a mean difference of 3.1°F between observed and predicted water temperature. The maximum difference was 5.4°F, and the minimum difference was -0.5°F. It is unusual to model a stream with a limited database as in this study; however, given the situation, this verification result should be adequate for this type

of feasibility study. It should be noted that the model tends to overpredict temperature by 1.8°F to 3.9°F.

Water Temperature (SNTEMP) Simulation

The goal of the simulation runs for Calaveras and Alameda Creeks was to describe the relationship between water temperature and flow recommendations. Five simulation runs using release rates of 2, 5, 10, 15, 25, and 30 cfs with warm hydrological conditions from Calaveras Reservoir and warm meteorological conditions were made using the verified model.

Before simulation runs are made, data and parameters that influence the model, such as flow rates, water temperatures, and meteorological conditions, must be defined. Meteorological and temperature conditions, as well as assumptions used in the simulation runs, are described below.

The meteorological data used in the simulation runs were the conditions that occurred on the maximum and median thermal loading days observed with a continuous input flow (in this case, 5 cfs). The thermal loading for each day between August 4 and 24, 1992, was calculated by subtracting the simulated water temperature between two model nodes. This period was chosen because it was the time of greatest thermal loading and highest range of water temperatures. A relatively low flow of 5 cfs was used because thermal loading would be accentuated at lower flow. The maximum thermal loading day was August 10, 1992, and the median thermal loading day was August 11, 1992. Once the maximum and the median days were determined, the corresponding observed meteorological data for those days were used for all simulated flow rates.

Meteorological data collected at the study site was limited to a period in August and September 1992. Available meteorological records at other regional locations (San Francisco, Stockton, and Sacramento) during this two-month period were assembled and compared to long-term records for the same locations. The station with data most closely resembling the Alameda Creek site was Sacramento, which experienced its third warmest August on record in 1992. Based on this observation, use of the August 1992 meteorological data collected at the study site for simulations is a conservative (worst case) assumption.

Inflow temperature to the model (Calaveras Reservoir release temperature) used in the simulation runs for the six flow rates was assumed to be 59°F, which is about the average temperature at the dam during the release period. Calaveras Reservoir was at a relatively low level during the study, and based on the discussion of Calaveras Reservoir thermal stratification, this temperature is higher than would typically occur. More typical release temperature should not exceed about 54°F.

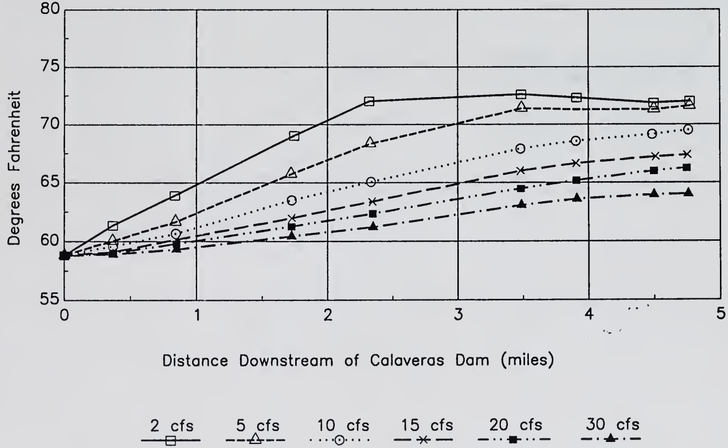
The simulation results are shown in Figures 3-3 and 3-4. Simulation runs for the maximum and median thermal loading day for all flow rates show a similar pattern of increasing water temperatures moving downstream. Not surprisingly, simulation runs using the maximum thermal loading day predicted water temperatures higher than the median thermal loading day. The rate of increase in water temperature traveling downstream is greatest when the release rate was lowest (2 cfs) and smallest when the release rate was highest (30 cfs).

Based on the simulation runs and assuming that a daily average water temperature of 68°F would provide suitable conditions for trout, Biosystems concluded that flows of 15 cfs from Calaveras Reservoir during summer would provide suitable temperature conditions for trout downstream from Calaveras Dam as far as the Sunol Treatment Plant. This flow rate is based on a worst-case scenario (i.e., hottest meteorological conditions with warmest release condition).

WATER QUALITY

Water quality samples were collected during each level of the flow release. Measured parameters included water temperature, dissolved oxygen, pH, and hydrogen sulfide. Duplicate samples were collected at each site for analysis of copper, iron, and manganese. The metals samples were taken because copper sulfate has been used in the reservoir to control algae and may persist at elevated levels. High levels of solubilized iron have been noted in previous reservoir sampling data, and a recent spill of potassium permanganate downstream has caused interest in background levels of manganese. Samples were collected just below Calaveras Dam, at the upper transect site just below the Alameda Creek confluence, and at the lower transect site above Calaveras Road (Figure 3-2). Water temperature and dissolved oxygen were recorded *in situ* using a YSI meter. Water temperature was recorded only to calibrate the dissolved oxygen measurement and as a check against the instream temperature monitors (datapods). The pH and hydrogen sulfide concentrations were recorded *in situ*.

A complete summary of water quality measured during the experimental releases is contained in the fisheries report in Appendix E. Although the sampling program conducted in this study was not designed to monitor compliance with regulatory policies, EPA water quality criteria for the protection of aquatic life as guidelines for identifying potential water quality problems in the creek were used. Comparison of measured quality to the EPA standards showed that all water quality parameters were within acceptable limits for rainbow trout during the entire flow release period. No water quality conditions were observed that would preclude the establishment of a rainbow trout population.



ALAMEDA CREEK WATER RESOURCES STUDY

SNTEMP SIMULATION RESULTS FOR ALAMEDA CREEK

FOR MEDIAN THERMAL LOADING DAY

SAN FRANCISCO WATER DEPARTMENT

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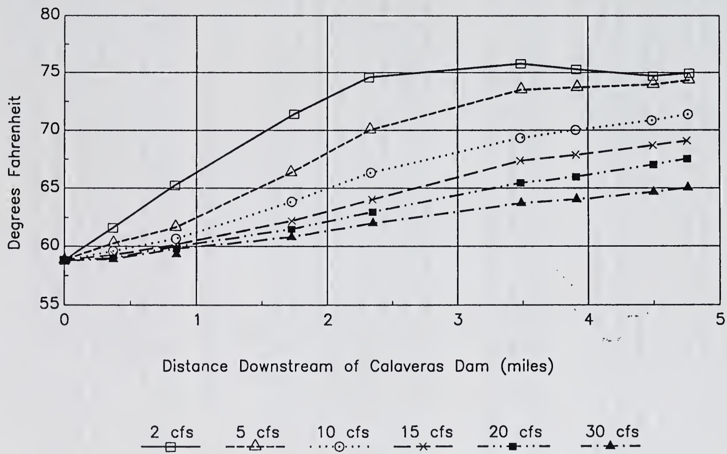


ALAMEDA CREEK WATER RESOURCES STUDY

SNTEMP SIMULATION RESULTS FOR ALAMEDA CREEK

FOR MAXIMUM THERMAL LOADING DAY

SAN FRANCISCO WATER DEPARTMENT

FISHERY MANAGEMENT OPTIONS

Based on the technical investigation conducted for this study, suitable habitat conditions for trout can be maintained from Calaveras Dam downstream to the Sunol Valley Water Treatment Plant with flow augmentation. The range of flows, predicted from modeling simulations, needed to restore the trout fishery downstream to the filter plant could also physically ~~be provided~~ by the SFWD. Although the trout fishery could be restored in the creek, Dr. Peter Moyle, professor of fisheries at the University of California at Davis, in reviewing ~~an initial~~ draft of the fisheries report, expressed the opinion that the trout restoration efforts may result in a decline in the population of native nongame fish. He proposed developing a comprehensive management plan that would consider the needs of other nongame fisheries.

To identify the preferred management plan for Alameda Creek, the SFWD held a meeting on August 3, 1993, with the interested parties to solicit their input. In attendance were representatives from the University of California at Davis, CDFG, California Trout, and the SFWD.

Five management alternatives for Alameda Creek were presented at this meeting. These were discussed in detail and refined based on comments provided in the meeting. The final version of each of the management alternatives is summarized in Table 3-1 and discussed below. Four alternatives recommend that the rainbow trout fishery be enhanced. These alternatives differ in the degree of exploitation by anglers of the trout fishery and the relative impact of each plan on the native fish community. The fifth alternative provides for protection and enhancement of the native fish community without an emphasis on rainbow trout. A preferred management plan for Alameda Creek was selected from these alternatives.

ALTERNATIVE 1—FULL EXPLOITATION OF RAINBOW TROUT FISHERY

The main objective of this alternative would be to maximize recreational fishing opportunities for trout in Alameda Creek below Calaveras Dam. Of course, some limits must apply to prevent the resource from being overexploited. This alternative would involve an extension of the Niles Canyon fishery upstream into Sunol Regional Park. Suitable habitat conditions for trout from Calaveras Dam downstream to the Sunol Treatment Plant would be maintained by flow augmentation. Flow augmentation would be provided to maintain cool temperatures (<20°C) during the summer and to increase trout spawning habitat in the late winter.

Trout would be obtained at hatcheries and stocked in the stream to support the fishery. Although some natural reproduction may occur, it would not be relied upon to support the trout population or the fishery. This model has examples all over the state. Some

Table 3-1
Potential Management Alternatives Considered for Alameda and Calaveras Creeks on San Francisco Water Department Lands

Management Alternative	Target Species	Management Objective	Stocking Program	Flow Regime Objective	Disadvantages
1. Full exploitation of rainbow trout fishery	Rainbow trout (native and hatchery)	Provide maximum fishing opportunity	Stocking of hatchery rainbow trout required	Provide suitable temperature (≤20°C) for trout from Calaveras Dam to Sunol Filter Plant	Loss of genetic stock of native rainbow trout
2. Limited exploitation of rainbow trout fishery	Rainbow trout (native)	Protect genetic stock of rainbow trout Provide limited fishing opportunity	"Restocking" of stream using native rainbow trout may be required	Provide suitable temperature (≤20°C) for trout from Calaveras Dam to Sunol Filter Plant Provide spawning flow for trout	May reduce abundance of native nongame fish
3. Full protection of native rainbow trout	Rainbow trout (native)	Protect genetic stock of native rainbow trout	"Restocking" of stream using native rainbow trout may be required	Provide suitable temperature (≤20°C) for trout from Calaveras Dam to sunol Filter Plant Provide spawning flow for trout	No fishing opportunities May reduce abundance of native nongame fish
4. Protection and enhancement of native rainbow trout and native nongame fish	Native fish	Protect and enhance genetic stock of native rainbow trout Protect and enhance native nongame fish	None	Improve temperature conditions for native rainbow trout in upper reach Increase habitat for native nongame fish in lower reach	Limited fishing opportunities Trade-off between habitat conditions for rainbow trout and native nongame fish (neither maximized)
5. Protection and enhancement of native nongame fish	Native nongame fish	Protect and enhance native nongame fish	None	Mimic unimpaired flow regime (summer water temperature >20°C In most areas)	No fishing opportunities Native rainbow trout may be lost

notable local examples, in addition to Niles Canyon, include San Pablo Reservoir and Lake Merced in San Francisco. This approach is not unique and is consistent with decades of fishery management practice.

Drawbacks to this option are that, in practice, it becomes more an exercise in management of a resource because of an emphasis on sport fishing. Implementation of this option may be in conflict with the goals of the East Bay Regional Park District which manages Sunol Park with a distinct emphasis on its wilderness values. Large numbers of recreational fishermen would degrade the riparian environment, disturb wildlife, and, as a new user group, would inevitably come into conflict with existing uses of the park. These problems would also spill over onto nearby SFWD lands.

Other drawbacks of this alternative include the potential loss of the genetic stock of native rainbow trout currently residing in the creek after hatchery fish are introduced. This loss would be significant if the resident trout are remnants of the steelhead which once made spawning runs into the creek. The abundance and species composition of the native fish population residing in the creek may also be substantially altered under the proposed flow regime. The plan would result in summer instream temperatures of less than 68°F downstream to the filter plant, with the majority of the creek less than 64°F. In general, native nongame fish populations are reduced in areas where summer instream temperatures are less than 64°F.

Alternative 2—Limited Exploitation of Rainbow Trout Fishery

The objective of this alternative is to provide suitable habitat conditions for native rainbow trout from Calaveras Dam downstream to the Sunol Treatment Plant. Furthermore, once the trout population became established, a limited fishery for native trout would be developed. This alternative may require "restocking" of the creek using native rainbow trout from other stream in nearby watersheds. Since native rainbow trout populations are known to exist in Alameda Creek (below Little Yosemite area) and in Arroyo Hondo, it makes sense to use these as a source stock for restoration in Calaveras and Alameda Creeks. Flows in the creek would be increased during the summer to meet instream temperature goals and during the late winter to increase spawning habitat for trout.

This alternative would maintain the benefits of a native self-sustaining rainbow trout population and provide an exceptional fishing opportunity to a limited number of individuals. To be fair, entry to the fishery could be through a lottery, as is currently done for much waterfowl and big game hunting. The season could also be limited to a few weeks during times that would not interfere with spawning. Special gear restrictions or catch-and-release requirements could also be used, as could limiting the areas open to fishing.

This option could necessitate additional enforcement effort. Trout population levels would need to be carefully monitored before and after the exploitation periods to set harvest limits

and other specifications. Such a fishery should be initiated only on an experimental basis, after it has been determined that the population is sufficiently healthy. Care should be taken to ensure that the level of use is low enough to protect the population and the sensitive riparian habitat. This could provide a unique, high-value fishery.

The main disadvantage of this alternative is that the population of native nongame species in the creek may be adversely impacted. The proposed cool summer temperatures (<68°F) for the creek may severely restrict the range of some native species. Populations of exotic species may also increase in abundance and compete with native species under the proposed flow regime.

ALTERNATIVE 3—FULL PROTECTION OF NATIVE RAINBOW TROUT

The objective of this management alternative would be to provide conditions under which a population of genetically distinct native rainbow trout could maintain itself in its natural environment. Stream management would provide conditions to ensure completion of each phase of the life-cycle. Flows in the creek would be augmented in the summer for temperature control and in the winter to increase spawning habitat.

Stocking hatchery strains of rainbow trout would not be consistent with this objective. With flow augmentation, the population of rainbow trout above the confluence of Alameda and Calaveras Creeks probably will expand downstream into suitable areas of the creek. If this natural process does not occur, or if it needs to be supplemented, stock from Arroyo Hondo, other Calaveras basin tributaries, or other East Bay native stock (such as San Leandro drainage) may be suitable for transplant downstream of Calaveras Reservoir. Both CDFG and California Trout are in favor of using native stock to repopulate the creek. The East Bay Regional Park District has used native stock from the San Leandro basin to restock Wildcat Creek below Jewel Lake, and Redwood Creek, in Redwood Regional Park, is managed for its wild trout population.

The disadvantages of this option are that no trout fishing opportunities would be developed and native nongame fish may be adversely impacted. Increasingly, fisheries management agencies, as well as a wide spectrum of the public, are focusing on management for biotic diversity and nonconsumptive values as an important goal. Although this alternative would increase the range and abundance of native trout in the Bay Area, it may actually decrease biodiversity in Alameda Creek by reducing the native nongame fish community.

ALTERNATIVE 4—PROTECTION AND ENHANCEMENT OF NATIVE RAINBOW TROUT AND NONGAME FISH

This alternative attempts to protect and enhance both the native rainbow trout fishery and the native nongame fishery by creating habitat conditions in Alameda Creek that benefit both populations. In this scenario, habitat conditions are not maximized for either

population in the creek. Instead, the recommended flows represent a trade-off between the different requirements of the target species. Flow augmentation occurs at the same time (summer and late winter) as in the previous alternatives, but lower flows are recommended. The recommended summer flows provide suitable temperatures for trout (<68°F) only in the upper half of the study area (from Calaveras Dam downstream to the Sunol Regional Park). Temperature conditions in the lower half of the creek would exceed 68°F for most of the summer; this condition is more suitable for native nongame fish. Spawning flows in the late winter for rainbow trout would also be reduced.

A limited recreational fishery for rainbow trout could be established if the native trout population increases under this flow regime. A monitoring plan and harvest restrictions would need to be implemented to ensure protection of the trout population (details are outlined under Alternative 2). To protect the genetic integrity of the native trout population, no hatchery fish would be stocked into the watershed.

This alternative would ensure that biodiversity is maintained in the creek by improving habitat conditions for both native trout and nongame fish. The disadvantage of this alternative is that fewer trout would be present in the creek and opportunities for angling would be reduced.

Alternative 5—Protection and Enhancement of Native Nongame Fish

The objective of the final alternative under consideration is to provide habitat conditions in the creek to maximize the protection and enhancement of the native nongame fishery. Unfortunately, the habitat requirements of many native fish are not fully known, making efforts to identify flows which maximize benefits to native fish more difficult than those for rainbow trout. Our approach to recommending flows for native fish would be to mimic the unimpaired seasonal flow pattern for the creek and release lower flows in the summer to maintain warm instream temperatures (>68°F) in the creek from Calaveras Dam downstream to the Sunol Valley Water Treatment Plant. These warmer summer temperature conditions should favor the native nongame fish community.

The disadvantage of this alternative is that the native rainbow trout fishery may be lost as well as the recreational value to sport fishermen. There is also considerable uncertainty about the effect of the recommended flows on the native nongame fishery. An annual monitoring plan would need to be implemented to document changes in the abundance and distribution of native fish in the stream. The potential loss of rainbow trout would decrease overall biodiversity in the creek.

PREFERRED FISHERY RESTORATION PLAN

After careful deliberation, Alternative 4 (Protection and Enhancement of Native Rainbow Trout and Nongame Fish) was selected as the preferred alternative by all parties. Although

this alternative does not maximize habitat conditions for either rainbow trout or native nongame fish, it does provide for a balance between the requirements of these fisheries. The plan provides for a limited wild trout recreational fishery, if the population is monitored closely. Biodiversity in Alameda Creek is enhanced under this alternative with the upper half of the study reach (Calaveras Dam to Sunol Regional Park) managed for trout and other native cold-water species and the lower reach (Sunol Regional Park to the Sunol Treatment Plant) managed for native warm-water nongame fish. The flow and reservoir management recommendations for Alternative 4 (discussed below) are also consistent with the conjunctive use program currently being developed by the SFWD.

Flow and Reservoir Management

As a result of the fisheries studies described above, the following recommendations are presented as the basis for a native fish enhancement plan in Alameda Creek:

- **Maintain historical Calaveras Reservoir stratification conditions.**

  Based on available SFWD reservoir temperature profiles, Calaveras Reservoir has historically been stratified during much of the year into two layers: a warm, upper layer and a colder, lower layer. Enhancement of downstream flow conditions for a rainbow trout fishery will require availability of the cold water contained in the lower layer of Calaveras Reservoir. The water temperature profile in Calaveras Reservoir should be reviewed periodically after the aeration system is in operation to ensure that favorable water temperatures for fish releases are maintained.

- **Maintain 30,000 AF in Calaveras Reservoir storage at end of October.**

  Deterioration of the cold water pool and potentially harmful release temperatures may occur when Calaveras Reservoir storage falls below 30,000 AF in the late summer, as occurred in 1990. Flow release schedules should be developed to preserve this level of storage into late October. In low runoff years, spawning and rearing flows may need to be reduced to suboptimal levels to preserve cold-water releases throughout the summer.

- **Provide a 5-day running average flow of 5 cfs immediately below the confluence of Alameda Creek and Calaveras Creek from November 1 through January 31 with a minimum mean daily flow of not less than 4.5 cfs.**

  Flows of 5 cfs provide suitable micro-habitat conditions for all rainbow trout life-stages, but field observations suggest adults may do better at higher flows. This recommendation can be refined through monitoring of the trout population and IFIM studies.

- **Provide a 5-day running average flow of 20 cfs immediately below the confluence of Alameda Creek and Calaveras Creek from February 1 through March 31 with a minimum mean daily flow of not less than 18 cfs.**

  In Alameda Creek, rainbow trout appear to spawn earlier than other populations in California, with fry being observed in mid-February. This spawning pattern is similar to that of the historical steelhead population that made spawning runs into the creek prior to development in the watershed. This suggests that the trout population in the creek may be remnants of the historical steelhead population.

  Flows of 20 cfs during the spawning period provide much better conditions than lower flows. The actual spawning period in Calaveras and Alameda Creeks should be accurately defined through spawning surveys, and the spawning flow period adjusted accordingly. Ramping up to this level early in the period may be appropriate. Most of the potential spawning habitat is in Alameda Creek below the confluence with Calaveras Creek. There may be significant runoff from Alameda Creek during the spawning period which would contribute to the target flow of 20 cfs. At these times, releases from Calaveras Dam may be reduced to 5 cfs.

- **Provide a 5-day running average flow of 7 cfs immediately below the confluence of Alameda Creek and Calaveras Creek from April 1 to October 31 with a minimum mean daily flow of not less than 6.3 cfs.**

  Flows of 7 cfs will maintain an average daily temperature of 68°F or less from Calaveras Dam downstream to Sunol Regional Park during the maximum heating period. The lower reach from Sunol Regional Park downstream to the Sunol Treatment Plant will be warmer and, therefore, more suitable for the nongame native fish. Suitable micro-habitat conditions for all life stages of trout occur at this flow. Temperature monitoring should be used to verify the results of the SNTEMP model since it was calibrated with a very limited data base.

- **Monitor downstream temperatures to verify model results.**

  The SNTEMP model provides our best estimate of temperature conditions, but it was calibrated based on a very limited data base. Monitoring of stream temperatures should be used to verify the model predictions. The flow recommendations presented here should not be taken as absolute. In many cases, it may be appropriate to maintain the recommended flow as an average over some period, such as two weeks, as long as the flow fluctuations are not extreme.

- **Evaluate the need for periodic flushing flows.**

  High winter flows are important for maintaining stream channel characteristics and particularly for maintaining the clean, loose aggregations of gravel necessary for trout spawning. Historically, peak flows, averaging 120 cfs and higher in January, February, and March, may have prepared gravel beds as flows receded in March, April, and May. With current SFWD operations, high flows still occur, but on a less frequent basis, approximately once every five to six years. Evaluation of peak flows needed to maintain important channel features was not part of this study, but it is important to address this issue if trout restoration is pursued. Other approaches besides high winter flows may also be appropriate for this purpose, including placement of spawning gravel in the stream and physically loosening and cleaning existing gravel deposits using heavy machinery. The need for and implementation of these management actions should be evaluated after the population becomes established and should be based on measurements of spawning habitat characteristics and trout spawning success.

HABITAT ENHANCEMENT OPPORTUNITIES

The design of fishery restoration projects must address the specific limiting critical habitat needs, beginning with the most critical factor. This study has identified instream flows, especially during the summer, as the critical factor limiting trout populations in Calaveras and Alameda Creeks. The enhancement plan, at this stage, should therefore focus on providing flows to meet basic habitat requirements to enhance native fish populations in the stream. Habitat improvements and stocking are not essential to establishment of a trout population in Calaveras and Alameda Creeks. The study also identified secondary factors that may limit the fish populations after they become established. These include lack of deep-water habitat for adults and some degradation of the riparian community because of grazing in certain areas. Once instream flows are provided and native fish population are in the process of becoming established, careful monitoring should be used to identify areas where further restoration efforts may be beneficial.

Although development of a habitat improvement program is not recommended until further progress is made in restoring native fish populations, some preliminary recommendations can be made based on habitat data collected during the field surveys. First, reducing access of cattle to the stream channel will improve riparian and stream habitat conditions, resulting in increased fish populations.

Second, cattails in the area of Sunol Regional Park may hinder fish movement and occupy habitat that would otherwise be suitable for fish. Cattails are hard to eradicate and will require more than physical removal. One method is creation of unsuitable conditions for cattail growth, such as shading and deep water (>3.5 feet). Increased riparian vegetation

to increase shading in areas where cattails are a problem may help to exclude them from the stream.

In the event that permanent flows are restored in the creek for the purpose of establishing a trout fishery, it is recommended that the creek be further evaluated to identify potential opportunities for habitat restoration using guidelines outlined in the California Salmonid Stream Habitat Restoration Manual. This manual includes a standardized and accepted procedure for determining habitat restoration needs based on target species, life stages, and current instream conditions.

This procedure calls for a complete stream habitat inventory, including steam classification, and channel and habitat typing. In addition, fish distribution in the stream is evaluated by conducting adult spawning surveys and determining species composition and age class. The physical habitat and fish distribution inventories are then summarized and used to determine whether a restoration project would be beneficial to the stream's fishery. In the case of Calaveras and Alameda Creeks, we would recommend that habitat and fish inventories be conducted after implementation of permanent flow releases and fish stocking program (if any).

Funding for a restoration project could be a joint venture between SFWD and East Bay Regional Parks. Also, CDFG funds salmonid restoration projects under their Fisheries Restoration and Enhancement Program. To obtain such funds, the interested party must respond to a Request for Proposal issued annually in February. The proposal must include a description of a specific program to be implemented (e.g., exclusion fencing, barrier removal, etc.). CDFG ranks all received proposals and provides funding to high priority projects.

The first groundwater development in the Sunol Valley occurred in 1900 and 1901 with construction of the Sunol Infiltration Galleries and Water Temple. These facilities, located at the downstream end of the Sunol Valley, capture rising groundwater and streamflow percolation during high flows on the Alameda Creek. Since 1901, essentially no additional groundwater development has occurred in the Sunol Valley.

Although the Sunol Infiltration Galleries provide some capability for recovery of groundwater in the Sunol Valley, they provide limited operational flexibility. They are constructed to a depth of approximately 20 feet and can only extract shallow groundwater. The Sunol Valley groundwater basin must be maintained in an essentially "full" condition for the Sunol Infiltration Galleries to function.

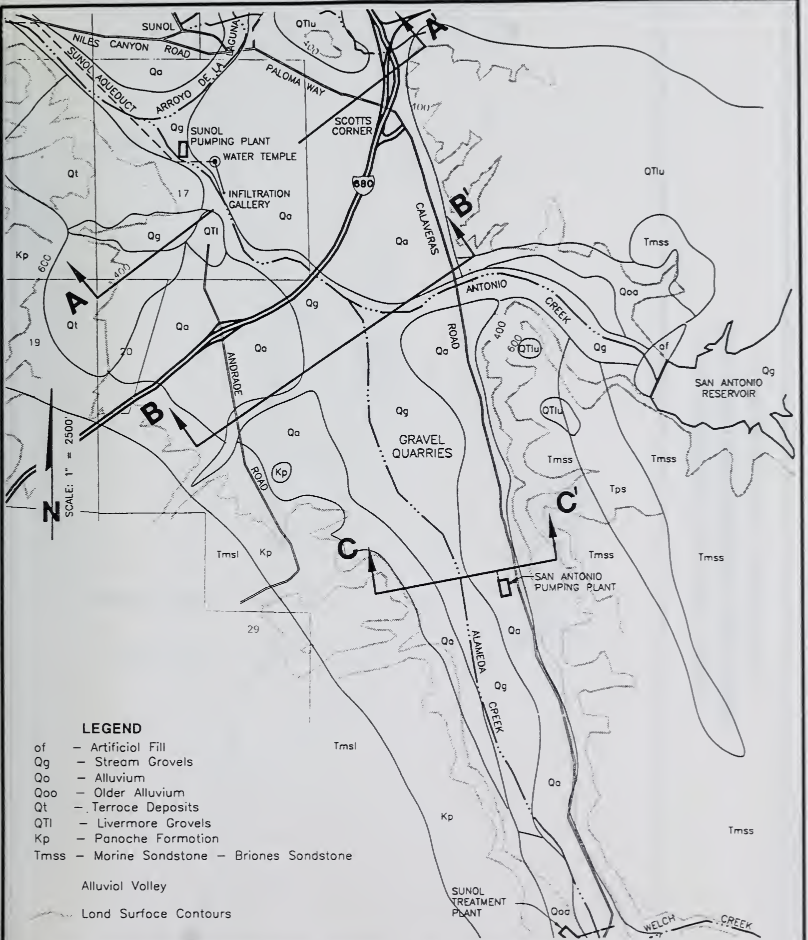
Previously, investigators have considered the potential for conjunctive use of the Sunol Valley groundwater basin. Conceptually, such conjunctive use would include planned recharge of the groundwater basin in wet years and extraction during droughts. One of the primary objectives of the Alameda Creek Water Resources Study was to investigate the feasibility of such an operation.

This section summarizes the results of the groundwater studies conducted to identify conjunctive use capability in the Sunol Valley. Initially, the geologic framework of the Sunol Valley is described. Then, groundwater flow conditions, aquifer properties that affect flow, and water quality conditions are documented. Finally, the study conclusions are presented which indicate that the potential for conjunctive use in the Sunol Valley is limited. A complete description of the groundwater investigations is provided in Appendix G, *Ground-Water and Aggregate Resources, Sunol Valley.*

GEOLOGY

The regional geology of the Sunol Valley has been described in studies by the California Division of Mines and Geology, the U. S. Geological Survey and the California Department of Water Resources. A simplified geologic map of the project area is shown in Figure 4-1 and three geologic cross sections are shown in Figures 4-2 through 4-4.

The most prominent structural geologic feature in the project area is the Calaveras Fault. The Calaveras Fault is an active fault located along the east of the Sunol Valley. In most of the valley, the trace of the fault is concealed below recent stream-deposited alluvium and landslides. Some studies have identified another fault, the Sinbad Fault, on the western side of Sunol Valley. The presence of such a fault could explain the broadness of the Sunol



ALAMEDA CREEK WATER RESOURCES STUDY

GEOLOGIC MAP

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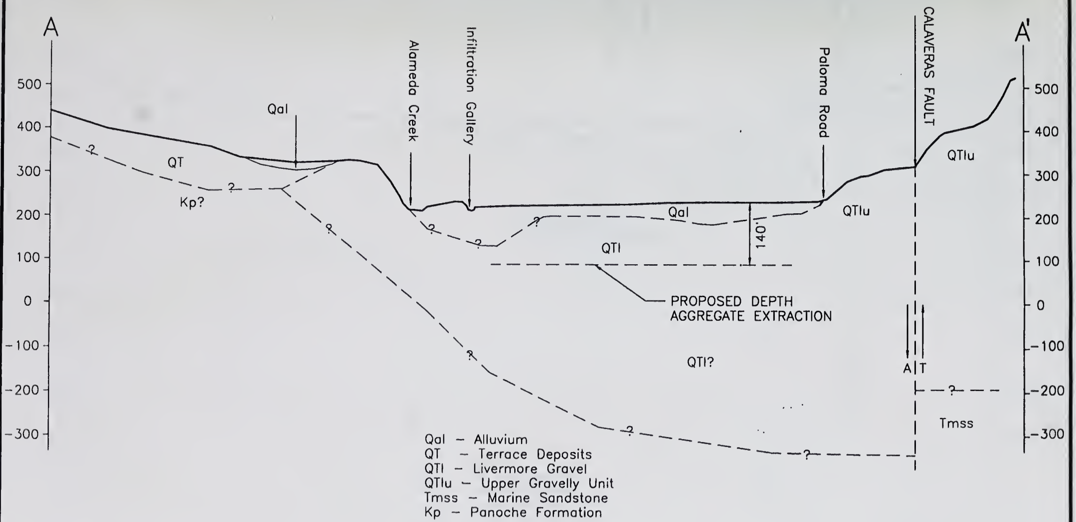
FIGURE 4-2



ALAMEDA CREEK WATER RESOURCES STUDY

GEOLOGIC CROSS SECTION A-A

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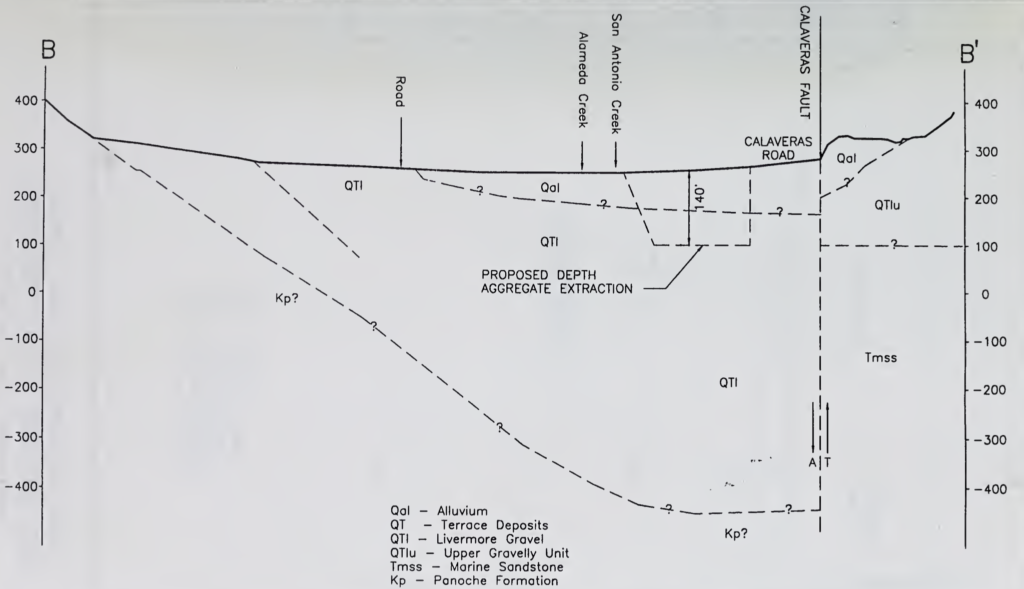
FIGURE 4-3



ALAMEDA CREEK WATER RESOURCES STUDY

GEOLOGIC CROSS SECTION B-B

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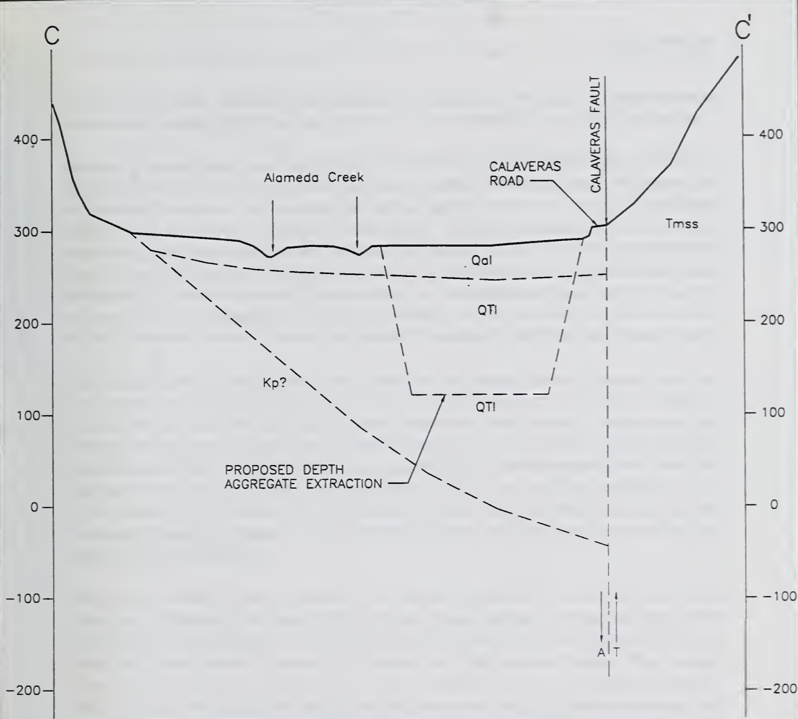
FIGURE 4-4



Qal — Alluvium
QT — Terrace Deposits
QTl — Livermore Gravel
QTlu — Upper Gravelly Unit
Tmss — Marine Sandstone
Kp — Panoche Formation

ALAMEDA CREEK WATER RESOURCES STUDY

GEOLOGIC CROSS SECTION C-C

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Valley in the north. However, the existence of the Sinbad Fault may be questionable as some recent investigations have not mapped or found evidence that such a fault exists.

Regarding groundwater potential, the geologic formations in the vicinity of Sunol Valley can be categorized into two groups–older and younger units. The older units in the study area include well compacted and consolidated marine sedimentary rocks that provide minimal groundwater and serve as bedrock in Sunol Valley. The oldest formation is the Franciscan Assemblage which generally outcrops east of the Calaveras Fault. The next oldest formation is the Panoche Formation, consisting of shales with sandstones and conglomerates, which outcrops only on the west of the Calaveras Fault on the west side of Sunol Valley. The most recent of the older formations is the Briones Sandstone which underlies the hills to the east of the Calaveras Fault and overlies the Panoche Formation in the hills west of Sunol Valley.

The younger geologic units in the Sunol Valley are the primary source of groundwater and include two individual formations–the Livermore Gravels and recent alluvium. Based on limited geologic data, the Livermore Gravels exist below Sunol Valley to depths of at least 500 feet and outcrop extensively east of the Calaveras Fault and north in Livermore Valley. The Livermore Gravels consist primarily of gravel beds that are interlayered with sand and mudstone beds. The gravel beds in the Livermore Gravels typically have a variable amount of clay matrix which reduces their permeability. Overall, the groundwater potential of the Livermore Gravels is unknown in the Sunol Valley since only a few wells extend into and produce from the formation.

The primary formation with groundwater development potential in the Sunol Valley is the alluvium. Alluvium in the Sunol Valley includes stream gravels, younger alluvium, older alluvium and terrace deposits. The stream gravels consist of sand and gravel which occur along the current stream channels of Alameda and San Antonio Creeks. The younger alluvium is the primary deposit on the surface of Sunol Valley and includes floodplain, stream channel and alluvial fan deposits of relatively recent origin. The older alluvium and terrace deposits are located on the higher areas of the land surface in Sunol Valley and underlying the more recent alluvium. Overall, the alluvial deposits range from 30 to 60 feet in thickness. Significant amounts of the recent alluvial deposits have been excavated by past gravel mining activities and will continue to be removed in the course of future mining. The excavation of portions of the recent alluvium could have beneficial impacts, however, through creation of potential surface storage reservoirs.

GROUNDWATER DEVELOPMENT

Prior to development, recharge to the Sunol Valley occurred primarily as seepage from the Alameda Creek stream channel and percolation of direct precipitation. Groundwater levels then would have been highest during the rain season and lower during the summer. Discharge from the basin would have consisted primarily of groundwater accretions to the channels of Alameda Creek and Arroyo de la Laguna at the downstream end of the valley.

The most notable development of groundwater in the valley has been the installation and operation of an infiltration gallery adjacent to the Sunol Water Temple. The infiltration gallery was constructed in 1900 and 1901 by SFWD's predecessor, the Spring Valley Water Company. Groundwater was backed up in the valley behind the Sunol Dam, which was constructed in 1889. The infiltration gallery, essentially a subsurface concrete tunnel with holes in the side walls, was constructed at depths varying between 10 and 20 feet below the original ground surface. Seepage into the infiltration gallery was subsequently increased through installation of perforated pipes directly beneath the Alameda Creek channel and through construction of gravel dams in the creek channel. The gravel dams raised the head in the stream channel and spread surface water onto larger areas of the floodplain, ultimately increasing hydraulic heads directly over the infiltration gallery. Groundwater collected in the infiltration gallery flowed downstream into the Sunol Water Temple and ultimately into the Niles Aqueduct. In the 1960s, the Sunol Pumping Plant was constructed to pump infiltration gallery flows into San Antonio Reservoir and to the Sunol Treatment Plant.

The infiltration gallery provides for a somewhat passive use of groundwater. The gallery increases the rates of groundwater discharge during periods of high flows and provides the capability for capture of controlled releases from the Calaveras Dam upstream. The infiltration gallery, however, does not allow for drawdown of groundwater storage during drought years as part of a conjunctive management plan. As originally constructed, the primary function of the infiltration gallery was the capture of flows in Alameda Creek. After 1934, those flows were controlled by Calaveras Reservoir and could be directly released through the Calaveras Pipeline directly to the Sunol Treatment Plant, dramatically decreasing the yield of the infiltration gallery. Recharge to the Sunol Infiltration Gallery was further reduced in 1965 when construction of San Antonio Dam eliminated supply from San Antonio Creek.

Besides the infiltration gallery, only incidental groundwater development occurred in the valley until recent times. This incidental development consisted of construction of a small number of wells for water supply principally for agricultural, industrial, or domestic purposes.

Beginning in the 1960s, gravel mining began altering groundwater flow patterns in the valley. Initially, the gravel quarries were constructed in the recent alluvium which yielded large amounts of water as the depth of the quarries extended into the groundwater table. Water collected in ditches in the bottoms or sides of the quarries was either used for processing operations or else was discharged into empty quarries or the creek. As the quarries were constructed into the Livermore Gravel formation, the quarry operators noticed only a small increase in the quantities of groundwater inflow. Where the recent alluvium yielded large amounts of water supply, groundwater flow from the Livermore Gravels was minimal. Mission Valley Rock, which operates several quarries in the Sunol Valley on its own land as well as leased SFWD lands, constructed slurry cutoff walls to limit

groundwater flow into the quarries. The cutoff walls were constructed only in the recent alluvium and resulted in negligible flow to the quarries. RMC Lonestar, which operates the other gravel quarries in the Sunol Valley pumps seepage from its pits for use in plant operations. As a result of the quarry operations, groundwater levels in portions of the valley are lower and flows into the filtration galleries have decreased in recent years. The last year of significant groundwater production from the filtration galleries was 1981. Since then, SFWD pumpage from the Sunol Pumping Station has been less than 100 AF in each year and no pumpage has been reported since 1984.

GROUNDWATER CONDITIONS

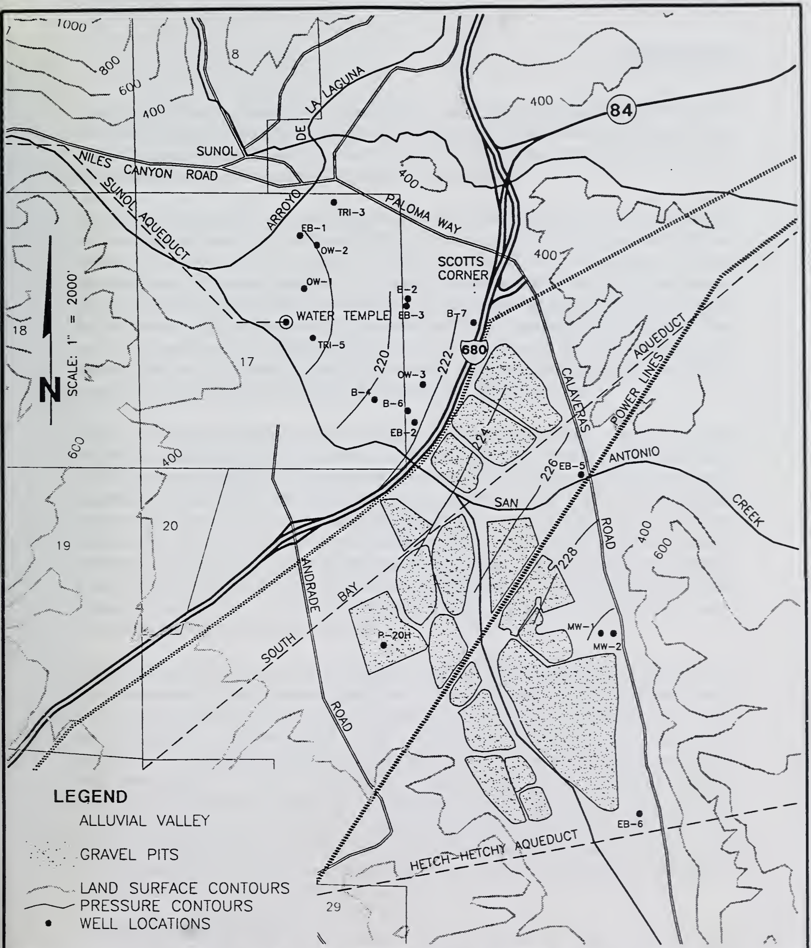
Available groundwater data in the Sunol Valley are somewhat limited. During previous investigations of the valley in 1986 by Alameda County Water District and in 1989 by Mission Valley Rock Company, several small diameter, mostly shallow, monitoring wells were constructed. Water levels were measured in these wells at the time of construction, but have not been measured routinely since then.

As part of this study, the previously constructed wells were measured several times in 1992 and 1993. Additionally, the ground surface elevations of the wells were estimated, either by survey or through reference to available topographic mapping of the valley.

Contours of measured groundwater elevations for November 1992 are shown in Figure 4-5. These water level contours generally parallel the ground surface contours of the valley floor. The water levels are lowest at the base of the valley, near the Sunol Water Temple where groundwater discharges in the Sunol Infiltration Galleries. Groundwater levels are highest in the southern, upper end of Sunol Valley where Alameda Creek provides a source of recharge. The generally sparse grid of well measurements does not allow assessment of possible lowered groundwater levels in the vicinity of gravel quarries.

Comparison of the recent groundwater level measurements with those collected in 1986 and 1989 showed no major changes in water levels. Comparison of seasonally collected water levels also showed relatively small variations from spring to fall. Overall, groundwater levels in Sunol Valley range from 20 to 30 feet deep, with probable localized depressions around the gravel quarries.

In previous studies of the Sunol Valley, slug tests were conducted for several shallow monitoring wells. The hydraulic conductivities from these tests (which represent the recent alluvium) vary from 50 to 150 gallons per day per square foot (gpd/ft^2). However, because the recent alluvium is relatively thin and large quantities have been removed during



ALAMEDA CREEK WATER RESOURCES STUDY

GROUND WATER ELEVATION CONTOURS

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quarry operations, the potential for groundwater development relying only on the recent alluvium is limited. Significant groundwater development in the valley would require use of the Livermore Gravels, which are several hundred feet in depth and potentially contain a majority of the groundwater storage space in the valley.

No aquifer characteristics have been reported for the Livermore Gravels in the valley, which is not surprising since only two production wells are known to be constructed into the Livermore Gravels in the entire valley. Of these two wells, one is a small capacity well that provides water for nursery irrigation. The other production well in the valley (located on the RMC Lonestar gravel lease) was formerly used to produce water for gravel processing, but its use was largely discontinued due to difficulties in maintaining well capacity. This well is 407 feet deep, with perforations from a depth of 23 feet to the bottom of the well. Although the well is perforated partially in the recent alluvium (from 23 feet to about 40 feet deep), the great majority of the perforations are in the Livermore Gravels.

Because of its larger diameter and the availability of a well log, the RMC Lonestar well was selected for aquifer testing. To conduct the test, the pump was removed from the well and a video log was prepared to document the well's construction characteristics and current condition. A test pump was installed and two different pump tests were conducted. Initially, the well was pumped at a rate of 95 gallons per minute (gpm) for 24 hours. Water levels in the well were recorded during pumping and were also recorded after the pump was turned off and the water levels recovered. In the second test, a packer was installed in the well at 50 feet to seal off inflow from the recent alluvium. The second pump test was conducted for 43 hours at a rate of 100 gpm. As with the first test, water levels were recorded both during and after pumping.

The second pump test was analyzed in greater detail than the first test because it represents the characteristics of the Livermore gravels only. Based on the results of the second pump test, the transmissivity of the Livermore gravels varied from 1,500 to 3,200 gallons per day per foot (gpd/ft) of aquifer width. This transmissivity is extremely low. Based on application of well hydraulic theory, the maximum yield of a well completed in an aquifer with transmissivity of 1,500 to 3,200 gpd/ft would be one to two gallons per foot of drawdown. Construction of wells that discharged 250 gpm (about .5 cfs, an extremely small production rate for a municipal supply well) would result in drawdowns on the order of 250 feet, a significant fraction of the entire depth of the Livermore gravel formation. Due to the extremely low aquifer transmissivities in the valley, development of significant groundwater in the valley would not be feasible.

GROUNDWATER QUALITY

Available groundwater quality data in the Sunol Valley are even more restricted than water level data. Limited water quality analyses were conducted as part of the 1986 ACWD and

Mission Valley Rock investigations. Additional water quality sampling was performed during the well test conducted for this study.

Where available, limited complete general mineral analyses indicate that the groundwater is of a calcium-magnesium bicarbonate type. Concentrations of TDS, for which data are more extensive, typically range from about 350 to 500 mg/l, although several sites had considerably higher concentrations. Although the TDS concentrations are generally lower than the secondary maximum contaminant level of 500 mg/l, they are considerably higher than SFWD's Hetch Hetchy Aqueduct supplies, which average 40 mg/l. Several groundwater quality samples located in the field west of I-680 had higher TDS concentrations ranging from 510 to 700 mg/l, which may be related to historical agricultural use at the site. One of the ACWD wells, located near the southwest rim of the valley, had very high TDS and chloride concentrations that may represent a different geologic formation than the recent alluvium and Livermore gravels that comprise the primary aquifer in the valley.

Reported concentrations of nitrate were generally low, typically falling between 1 and 6 mg/l, which is well below the maximum contaminant level of 45 mg/l. However, two wells located in the field west of I-680 had nitrate concentrations ranging from 62 to 177 mg/l, suggesting that some nitrate contamination of shallow groundwater may have resulted from historical cropping practices. In one of the shallow wells with high nitrate concentrations, a deep well located immediately adjacent had a nitrate concentration of 1 mg/l.

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SECTION 5 WATER SUPPLY OPERATIONS

Hydrologic studies were conducted to quantify the regulated water supply that can be provided by the southern Alameda Creek watershed. These hydrologic studies consider the natural runoff of the watershed and the operations of SFWD facilities which regulate this runoff.

The goals of the hydrologic studies were to:

- Evaluate the potential for increased water supply through coordinated operation of Alameda Creek facilities.

- Identify the adequacy of available water supplies for maintaining fisheries releases.

- Identify potential increases in yield through conjunctive operation of the Sunol Valley groundwater basin together with Alameda Creek surface water facilities.

To concentrate on these goals, the hydrologic studies have been focussed primarily on SFWD's southern Alameda Creek watershed facilities and did not directly consider possible coordination with Hetch Hetchy Aqueduct operation. Hetch Hetchy supplies and their impacts are, however, discussed for historical operations and are reviewed qualitatively for the constraints that they impose on Alameda Creek operations.

The hydrologic studies began with the estimation of natural runoff that occurs in individual portions of the southern Alameda Creek watershed. The runoff estimates were then combined with information on the capacity of SFWD facilities and their operational procedures to develop a computer operation model. A complete description of the operation model developed for Alameda Creek and its use are provided in Appendix F, *Report of Watershed Operations*.

HISTORICAL DEVELOPMENT OF SFWD FACILITIES

SFWD's predecessor, the SVWC, became actively involved in the Alameda Creek watershed in 1875, when it purchased the water rights of Vallejo Mills (SVWC, 1912). In addition to the Vallejo Mills water rights, SVWC purchased land at two sites, one on Alameda Creek at the mouth of Niles Canyon (near Vallejo Mills) and the other at the Calaveras Reservoir dam site. SVWC continued to purchase water rights and land in the Alameda Creek watershed after 1875. In 1886, the original Alameda Creek diversion works were completed at Niles, allowing diversions of Alameda Creek flows for delivery from the Transbay Pipeline at the Dumbarton Strait to San Francisco.

SVWC constructed the Sunol Dam in 1889. The original purpose of this dam was to provide an upstream point of diversion for Alameda Creek flows which would minimize the potential for water quality contamination in Niles Canyon from recreational usage. All SVWC operations prior to 1900 were dependent on naturally occurring streamflows in Alameda Creek without the benefit of significant regulatory storage. Streamflows were captured as diversion capacity and flows were available with large variations in both seasonal and annual diversions due to wetness conditions.

In 1900 and 1901, the SVWC raised Sunol Dam and constructed the Sunol Infiltration Gallery and Water Temple. Raising Sunol Dam had the effect of increasing Sunol Valley groundwater levels in large portions of the lower Sunol Valley. The upper 20 feet of these increased groundwater levels were then drained by the subsurface Sunol Infiltration Galleries and could be delivered directly through the Niles Aqueduct to the Transbay Pipeline. This mode of operation provided SVWC with greater control of water supplies and naturally filtered Alameda Creek supplies. The Infiltration Galleries, while not necessarily increasing the quantities of water supplies, provided higher quality water than unfiltered surface water.

Beginning in 1901, the SVWC developed groundwater wells in its Pleasanton wellfield for additional water supplies. Initially, pumped groundwater from the Pleasanton wellfields was delivered through the channel of Arroyo de la Laguna to the Sunol Infiltration Galleries. In 1909, a pipeline was completed from the Pleasanton wellfield that allowed direct supply to a collection point at the Sunol Water Temple, where pumped groundwater intermingled with Sunol Valley groundwater captured by the Sunol Infiltration Galleries. The Pleasanton wellfield produced a dependable source of supply without the dramatic seasonal and year-to-year variations of Alameda Creek streamflows.

Because of the large variations in Alameda Creek streamflows, the SVWC began planning for regulatory storage to capture wet year flows for later use. Two primary storage sites were identified in the Alameda watershed south of Sunol: Calaveras Reservoir and San Antonio Reservoir. The Calaveras Reservoir site was especially attractive, due to its large potential capacity (approximately 100,000 AF) and the quantity of available flows at the site. Construction on Calaveras Dam began in 1913 using the hydraulic fill method of construction. Storage at Calaveras began March 1916 with closing of gates on the dam. In March 1918, a large slide (700,000 cubic yards) occurred on the upstream face of the dam. Reconstruction of the dam, using the rolled fill method, was completed in 1925. With completion of Calaveras Reservoir, high flows on Calaveras Creek could be captured in the winter months of wet years to provide carryover reserves for multiyear droughts. Water released from Calaveras Reservoir at controlled rates would percolate into the Sunol groundwater basin for recapture in the Sunol Infiltration Galleries.

Construction of the Upper Alameda Diversion Dam and a tunnel to Calaveras Reservoir began in 1925 and was completed in 1931. These two facilities allowed diversion into

Calaveras Reservoir of the bulk of flow on the main stem of Alameda Creek, increasing the total supply provided by Calaveras Reservoir. In 1930, the City and County of San Francisco purchased the SVWC, and the SFWD became responsible for operating former SVWC facilities.

With completion of the Hetch Hetchy Aqueduct in 1934, additional facilities were constructed to directly supply Calaveras Reservoir supplies to the Aqueduct. An aerator was built at the base of Calaveras Reservoir, and the Calaveras Pipeline was built between Calaveras Reservoir and the Hetch Hetchy Aqueduct. With completion of these facilities, streamflows below the reservoir were limited to spill periods, dam seepage, and inflow from unregulated tributaries. Inflow to the Infiltration Galleries diminished significantly. Export pumpage from SFWD's Pleasanton Wellfield also ceased with availability of Hetch Hetchy supplies except for 15 months during the 1948-1949 drought. The Sunol Infiltration Galleries diverted relatively small amounts of Sunol Valley groundwater that was recharged by local runoff of small watersheds below Calaveras Reservoir and by spills from the reservoir. During high flow periods, gravel dams were frequently constructed in the Alameda Creek channel to increase seepage directly into the Infiltration Galleries, which continued a practice of the SVWC.

The remaining facilities in the southern Alameda Creek watershed, including San Antonio Reservoir, the Sunol Treatment Plant, Sunol Pumping Plant, and the San Antonio Pumping Plant, were constructed by SFWD in the mid-1960s. San Antonio Reservoir was completed in 1965 to provide regulatory storage for Hetch Hetchy Aqueduct, local San Antonio Creek runoff, and Sunol Infiltration Gallery supplies. The construction of San Antonio Reservoir (capacity, 50,438 AF) further reduced Sunol Valley streamflows and flows to the Sunol Infiltration Galleries. Groundwater collected in the Sunol Infiltration Galleries could be pumped through the Sunol and San Antonio Pumping Plants, either for storage in San Antonio Reservoir or for treatment at the Sunol Treatment Plant. The San Antonio Pumping Plant also provides the capability to move water from Hetch Hetchy Aqueduct to San Antonio Reservoir and from San Antonio Reservoir to the Sunol Treatment Plant. The Sunol Treatment Plant provides increased levels of water treatment for Calaveras and San Antonio Reservoir releases. Connection of Calaveras Pipeline to San Antonio Reservoir allows flow by gravity from Calaveras Reservoir to San Antonio Reservoir during periods when storage space at Calaveras Reservoir is unavailable. Most recently, the Calaveras Pipeline was replaced in 1991, and a compressor type of aerator was installed at the same time in Calaveras Reservoir to improve water quality conditions.

HISTORICAL OPERATION

To provide a starting point for describing operation of SFWD facilities in the southern Alameda Creek watershed, historical operations of the facilities were obtained and reviewed. Calaveras Reservoir operations are described in some detail, since they are dependent on local runoff conditions that can be reasonably simulated for an Alameda Creek-only

operations study. San Antonio Reservoir operations are also described later at a lesser degree of detail, since they are dominated by storage of Hetch Hetchy supplies and are variable on a daily or hourly basis due to immediate water supply conditions.

Based on operation records, SFWD has normally operated Calaveras Reservoir within a range of 40,000 to 100,000 AF. Calaveras Reservoir storage fell slightly below 40,000 AF in fall of 1964. Storage also was below 40,000 AF during the droughts of 1976-1977 and 1987-1991. Storage also was below 40,000 AF during the fall of 1974 and spring of 1975 because of construction activities on the dam. A correlation was developed that compared December 1 carryover storage to annual water production. A weak correlation coefficient was derived for this comparison indicating historical variations in operational policy that are not directly related to runoff conditions.

San Antonio Reservoir has generally been operated at storage levels greater than 20,000 AF, with exceptions occurring in the 1976-1977 drought and the 1987-1991 droughts. In the 1987-1991 drought, San Antonio Reservoir storage was initially drawn down steeply during 1987. The subsequent partial refilling in the reservoir during 1988 and 1989 reflects Hetch Hetchy supplies as well as purchases of South Bay Aqueduct water. A correlation of San Antonio Reservoir December 1 carryover storage to local water production revealed minimal correlation. Based on review of available records, the normal amount of carryover storage in San Antonio has historically been somewhere between 30,000 and 35,000 AF, essentially independent of water production.

Estimates of water production from the Sunol Infiltration Galleries were developed based on records of Sunol Pumping Plant usage for the years 1979-1984. The Pumping Plant has not produced significant quantities of water since 1984, possibly reflecting the development of gravel quarries in the Sunol Valley and a corresponding reduction in basinwide groundwater levels. Based on these records, there was a somewhat consistent amount of flow available at the Sunol Infiltration Galleries, averaging about 322 AF per month from January 1979 through June 1981. Prior to June 1981, this water production occurred year-round. Water production from the galleries has been minimal since June 1981, and no supply has been pumped from the Sunol Pumping Plant since 1984. Historically, the SVWC and SFWD constructed temporary gravel dams to increase Alameda Creek water levels in the vicinity of the Infiltration Galleries and to inundate higher portions of the creek bed that are underlain by perforated pipes connected to the Infiltration Galleries. The effect of these operations on increased water supply could not be determined from Sunol Pumping Plant data. SFWD currently does not construct the gravel dams.

STREAMFLOW

To provide usable estimates of local inflow in the southern Alameda Creek watershed for the entire study period, a combination of data sources were referenced. Initially, estimates of inflow to Calaveras Reservoir were developed based on recorded USGS measurements

at the Arroyo Hondo near San Jose gage. This gage is located upstream of Calaveras Reservoir and measures runoff from a 77.1-square-mile watershed, about 78 percent of the watershed contributing directly to Calaveras Reservoir. The USGS measured flows at the Arroyo Hondo gage from 1969 until the gaging site was discontinued after 1981. Estimates of Calaveras Dam inflow were developed for the 1969 through 1981 water years through adjustment of Arroyo Hondo flows for differences in drainage area. The Arroyo Hondo gage was then correlated with several other nearby streams with longer periods of record to extend the record for the 1918 through 1991 study period. The best correlation with a gaging station with long-term records was achieved with the Stevens Creek near Cupertino gage. This correlation was used to extend Arroyo Hondo flow measurements for the entire study period. Estimates of Calaveras Dam inflow (excluding diversions from Alameda Creek) were developed for the study period through adjustments of observed and estimated Arroyo Hondo flows for differences in drainage area and average annual watershed precipitation.

Natural streamflow runoff was then estimated for other watersheds, as shown in Figure 5-1. These streamflow runoff estimates were based on the Arroyo Hondo data and available SFWD or SVWC records with adjustments for drainage area, average annual watershed precipitation, and estimated watershed losses. For San Antonio Creek runoff, the streamflow records estimated in this manner were compared to SFWD water production estimates, particularly for peak runoff periods when local runoff was significant and for periods of small watershed import amounts. On average, the inflow into San Antonio estimated from Arroyo Hondo flows reasonably matched adjusted water production levels.

The estimated streamflows are summarized graphically in Figure 5-2. For the 1918 through 1992 study period, average natural runoff in the southern Alameda Creek watershed above Sunol is 59,700 AF. The largest component of this runoff is the direct inflow to Calaveras Reservoir, which is estimated to average 36,000 AF per year. Flows at the Alameda Creek Diversion Dam averaged 12,000 AF and flows at the San Antonio dam site averaged 7,200 AF per year. Local runoff below these facilities averaged 4,500 AF per year.

An additional analysis was required for quantities of Alameda Creek diversions at the Alameda Diversion Dam. The Alameda Tunnel has an estimated capacity of 650 cfs which, on a monthly average basis, would allow diversion of nearly all flows of the creek. However, in actual operation, the Alameda Creek Diversion Dam typically does not divert the entire amount of Alameda Creek flows. The Diversion Dam has historically been operated to pass storms with large quantities of debris (frequently, the first flood event of a water year) and also typically does not divert the entire amount of high flows. Because of these considerations, the amount of potential diversions from the Alameda Creek Diversion Dam was estimated, based on analysis of daily flow records from the Arroyo Hondo gage and investigation of several levels of diversion capacity. Monthly diversions were estimated from analysis of the daily records, added to the estimated direct inflow

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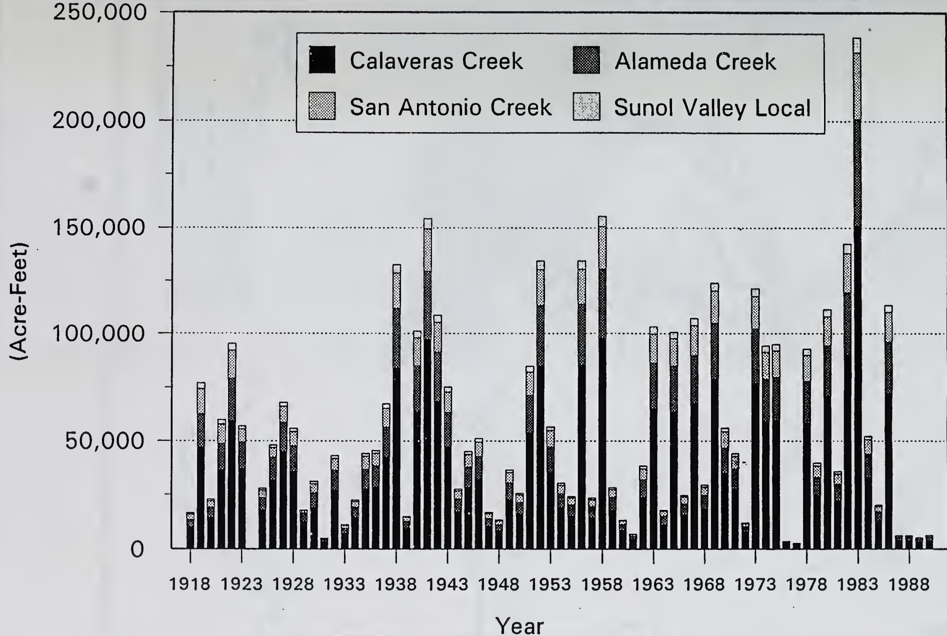
FIGURE 3-1



ALAMEDA CREEK WATER RESOURCES STUDY

WATERSHED NATURAL RUNOFF (1969-1990)

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JANUARY 1995

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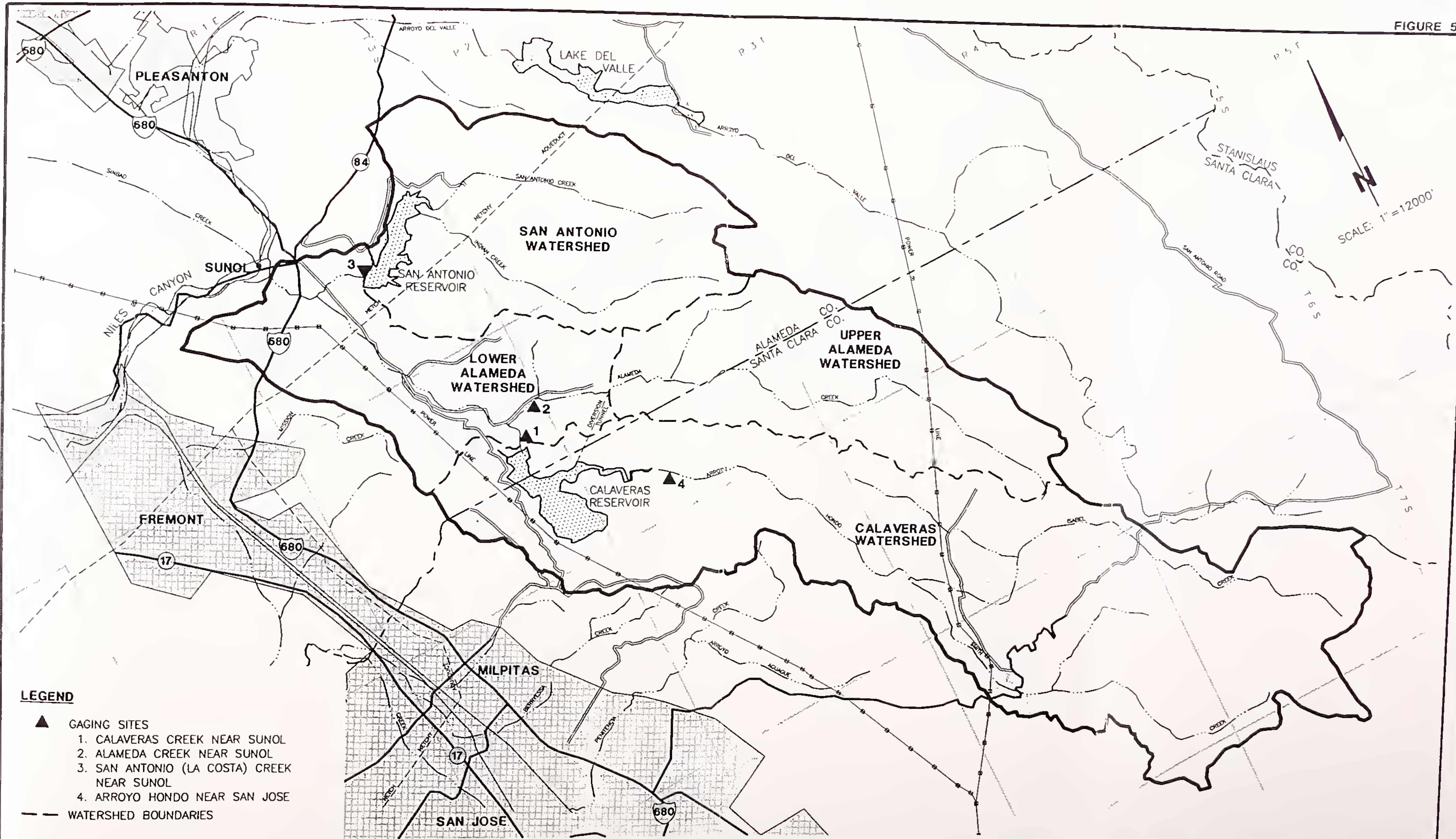
FIGURE 5-2



ALAMEDA CREEK WATER RESOURCES STUDY

WATERSHED BOUNDARIES AND GAGING STATIONS

SAN FRANCISCO WATER DEPARTMENT

BOOKMAN-EDMONSTON ENGINEERING, INC.

JANUARY 1995

to Calaveras Reservoir, and plotted against the calculated inflow from SFWD water production records. The comparison of estimated Calaveras Reservoir from both methods was very close, except for periods where spill was not included in the adjusted water production records. The estimated average amount of spills during the entire study period is 2,800 AF and the corresponding estimate of Alameda Creek flows that could have been diverted is 9,200 AF (12,000 - 2,800). The estimate of potential Alameda Creek diversion considered only the physical diversion capability of the Alameda Creek Diversion Dam and was not limited by Calaveras Reservoir storage considerations. When Calaveras Reservoir is at or near capacity, SFWD may choose not to divert flows into Calaveras Reservoir if there is no available storage space.

OPERATION MODEL

A reservoir operation model was developed to quantify the water supply available to the SFWD from the Alameda Creek watershed. The reservoir operation model attempts to mimic SFWD water management through computer simulation. In reality, operation of SFWD facilities varies daily and hourly depending on available reservoir storage, variations in user demands, Hetch Hetchy supply availability and power generation requirements, and water quality considerations. Development of a model that considers all these factors was outside the scope of this study.

In simulating SFWD operations in the Alameda Creek watershed, two major simplifications were made to facilitate numerical analysis. First, the reservoir simulation model uses a monthly time step. A monthly time step does not allow simulation of day-to-day operations that are affected by hourly variations in capacity, demand, and other factors. However, a monthly time step is considered appropriate for identifying seasonal variations in water supply and use conditions which are the primary concern of the Alameda Creek Watershed Study. Second, the reservoir operation model incorporates only local facilities of the Alameda Creek watershed. To varying degrees, SFWD facilities in the Alameda Creek watershed are physically or operationally affected by other facilities, primarily the Hetch Hetchy Aqueduct. San Antonio Reservoir, in particular, is directly connected to the Hetch Hetchy Aqueduct and provides storage space for supplies from the Hetch Hetchy Aqueduct.

The Alameda Creek Watershed Model has been developed using a numerical network flow model. Network flow models simulate water movement through a network consisting of nodes and arcs. In such a network, nodes represent geographic points, such as a branching location along a pipeline or a convergence of two stream channels. Arcs represent the channels that flow between nodes. Maximum and minimum flow amounts are specified for each arc, allowing specification of conveyance facility capacity (maximum) or required fisheries flows (minimum). Currently, the network flow model allows the user to specify up to eight reservoir levels that are used for balancing among reservoirs and for limiting diversion amounts. The network flow model internally specifies individual arcs for each

reservoir that represent user-specified reservoir storage levels. An arc is also included for carryover storage from one time step to another.

The network flow model is mathematically solved each month to result in the least cost. The unit cost of flow in each arc is specified that can be either a positive or negative number. These "costs" do not necessarily represent monetary costs, but can serve as a means for assigning relative operational priorities. For example, a water delivery channel could have a very low negative cost assigned which would cause the network flow model to supply as much water as possible to that channel. Conversely, the cost of spilling water from the network can be set as a very high number, making it very expensive to allow water to spill out of the system. Reservoir levels are normally specified as intermediate numbers that can change from month to month as a means of assigning water to storage.

The network flow model is solved using the out-of-kilter algorithm. This algorithm is a very efficient means of quantitatively solving the network flow model. The program is currently operating on a MS-DOS operating system that can be used on IBM-compatible personal computers. The Alameda Creek Operation Model was configured as shown in Figure 5-3.

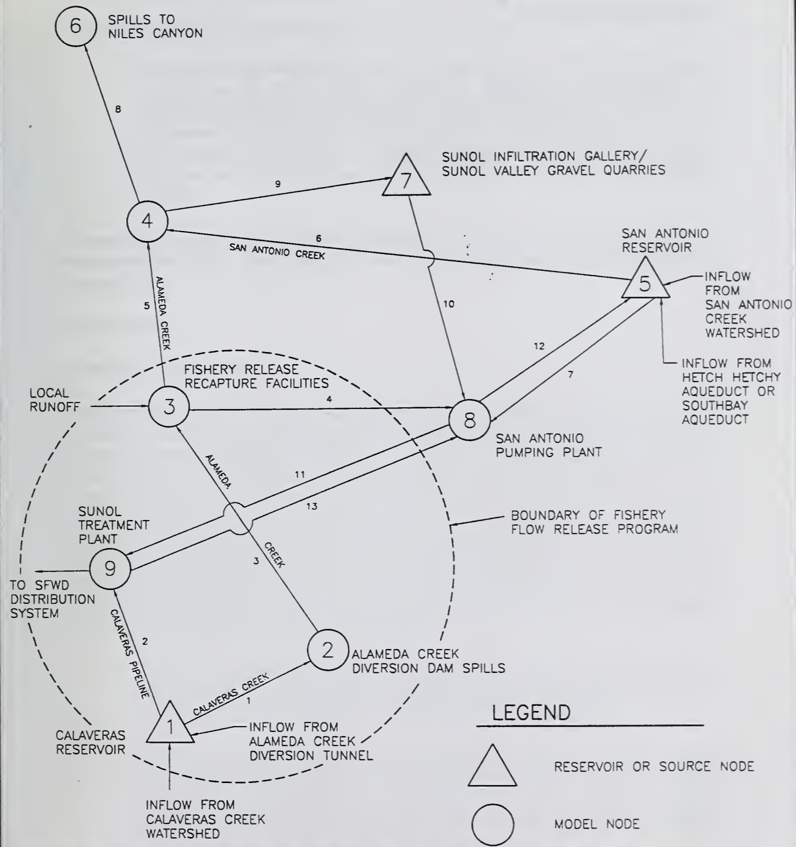
ALTERNATIVE ANALYSIS

The Alameda Creek Operation Model provides the capability for analyzing numerous possible water resource management alternatives. During the Alameda Creek Water Resources Study, four alternatives were identified for analysis using the model. These alternatives are summarized below:

- **Alternative 1, Base Case:** This alternative assumes the current configuration of facilities in the study area. This alternative further assumes that aggressive operations would be taken, such as routine reconstruction of gravel dams near the Sunol Water Temple, to maximize water recapture with the Sunol Filter Galleries.

- **Alternative 2, No Sunol Facilities:** This alternative assumes the current configuration of Alameda Watershed facilities, but differs from the Base Case in assuming that the Sunol Infiltration Galleries would not be operated.

- **Alternative 3, Fish Releases:** With this alternative, planned releases from Calaveras Reservoir for development of a fishery in portions of Calaveras and Alameda Creeks would be implemented as proposed in Section 3 and described in Appendix G, *Alameda Creek Watershed Study, Fishery Restoration Feasibility Evaluation and Preliminary Restoration Plan*. Downstream facilities would be constructed in Sunol Valley to recapture fishery releases.



NOTE:
SCHEMATIC OF FLOW ROUTING FOR MODELING PURPOSES ONLY; NOT GENERALLY REPRESENTATIVE OF ACTUAL PHYSICAL FLOW PATHS.

ALAMEDA CREEK WATER RESOURCES STUDY

ALAMEDA CREEK OPERATIONS MODEL

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2/9/95 T:/DWG/ALAMEDA/FIG5-3

- **Alternative 4, Quarry Reservoirs:** Under this alternative, reclamation of gravel quarries in the Sunol Valley would be planned for development of approximately 50,000 AF of regulatory storage. This regulatory storage would be operated in coordination with other Alameda Watershed facilities to increase the developed water supply. In addition to quarry operation, planned releases for instream flow would occur as proposed in the November 1993 fisheries report.

The assumptions made to represent each alternative in the Alameda Creek Operation Model are summarized below. The results of the alternative simulations are then described and compared.

ASSUMPTIONS

Alternative 1 (Base Case)

A base case was developed for the Alameda Creek Operation Model that represents current operational practices for the Alameda Creek. Facility limitations in the base case were set at current estimated operational capacities. Four different delivery levels from the Alameda Creek facilities were specified that correspond to equivalent reservoir storage levels. The delivery levels are a modeling convenience selected to ensure consistent monthly patterns of water delivery and are not representative of actual operational policies of SFWD. Variations in reservoir target levels can be used to achieve different delivery preferences for average versus dry period supply. The demands levels used in the base case were derived from interpretation of historical SFWD water production records; equivalent reservoir target levels were identified from review of historical reservoir operations. Each of the delivery levels utilized in this study are described below.

- Level 1 demands are of 12,000 AF per year represent the approximate amount of supply that can be sustained from the Alameda Creek facilities during the most extreme drought period in the record (1987 through 1992).

- Level 2 demands of 21,800 AF per year represent the supply that Alameda Creek can supply during intermediate years of moderate dry conditions. These demands are delivered by the model only when reservoir storage levels in Calaveras and San Antonio Reservoirs are above specified target levels providing for carryover of 52,000 and 20,000 AF, respectively.

- Level 3 demands of 30,000 AF per year can be met in most years and correspond to Calaveras and San Antonio Reservoir September 30 carryover levels of 60,000 and 30,000 AF, respectively.

- Level 4 demands of 50,100 AF per year are supplied only in years of above-normal wetness and correspond to Calaveras and San Antonio Reservoir September 30 carryover storage amounts of 80,000 and 38,000 AF, respectively.

In addition to the four model demand levels defined above, the model is also configured to "spill" surplus flows through the Sunol Treatment Plant to the extent that capacity is available. These spills represent an additional amount of supply that could be provided to SFWD customers on an irregular basis, but would result in inconsistent, and possibly unacceptable, water quality conditions to some customers. Because of the uncertainty about the potential for using irregularly supplied water from Alameda Creek, these delivery amounts were not considered as a supply in the analysis of model simulation results.

Alternative 2

Alternative 2 is nearly identical to Alternative 1 with the exception that the Sunol Infiltration Galleries recovery capacity is taken to be 0 AF per year. In Alternative 1, the Sunol Infiltration Galleries provide the capacity to recover 800 AF per year (an operational recovery rate based on recent monthly records that is lower than the historical peak recovery capacity of 38 cfs).

Alternative 3

Alternative 3 differs only slightly from Alternatives 1 and 2. With Alternative 3, the capacity of the Sunol Infiltration Galleries is again taken to be zero. However, Alternative 3 assumes that fisheries releases would occur and that facilities would be constructed in Sunol Valley to recapture those releases. The proposed fisheries flow requires approximately 1,200 AF per month in February and March for spawning and 300 AF per month in November, December, and January for flow maintenance. During the remainder of the year, flows of approximately 400 AF per month are required, primarily to maintain suitable temperatures for trout habitat in a portion of Calaveras and Alameda Creeks. In Alternative 3, fishery flow recapture facilities would be required to recapture the spawning fishery releases of 20 cfs (1,200 AF per month). These recapture facilities could also recreate the diversion capability of the Sunol Infiltration Galleries and divert unregulated local flows when capacity greater than the fishery releases is available. Four recapture facility capacities (20, 30, 50, and 100 cfs) were considered that provided varying capacities for unregulated flow diversion. Based on sensitivity analyses using the operation study, a recapture facility size of 50 cfs (6,000 AF per month) was selected for this alternative. The recapture facility size was selected based primarily on efficiency considerations. The assumed facility capacity is slightly less than the combined existing Sunol Pumping Plant capacity of 38 cfs and the maximum fisheries releases of 20 cfs.

Alternative 4

Alternative 4 differs most from the Alternative 1 Base Case. With Alternative 4, an additional 50,000 AF of reservoir storage space would be available in reclaimed Sunol Valley quarries. Available flows would be diverted into the quarry reservoirs at a maximum rate of 167 cfs and extracted with pumps sized for 83 cfs. These quarry intake and extraction rates are preliminary estimates that were selected to provide a general indication of the potential for water supply development with the quarries. Additional, detailed cost studies would be required to define the optimal size of intake and extraction facilities.

Since the quarries would be operated primarily for water supply purposes, reservoir levels were identified that operate the quarry reservoirs similar to Calaveras Reservoir. The availability of supplemental storage in the quarries also allowed revision of reservoir levels for Calaveras and San Antonio Reservoirs, since these reservoirs would not be required to maintain the same level of carryover storage as protection from droughts. Calaveras Reservoir carryover amounts were reduced approximately 15,000 AF for Levels 2, 3, and 4. Similarly, Level 2 in San Antonio Reservoir was reduced by 13,000 AF, although target Levels 3 and 4 were not modified.

MODEL SIMULATION RESULTS

The results of the operation model analysis of the management alternatives are summarized in Table 5-1. The most important number shown in this figure is the estimate of average deliveries. This estimate was computed by summing the deliveries that could be provided on a regular demand pattern for Levels 1 through 4. The average amount of deliveries for the base case, which assumes continued operation of Sunol Infiltration Galleries, was 37,700 AF per year. Loss of the Sunol Infiltration Galleries, as assumed in Alternative 2, results in average deliveries of about 36,500 AF, a reduction of about 1,200 AF per year from the base study. Implementation of planned fishery releases and the availability of fishery flow recovery facilities near the Sunol Treatment Plant result in average deliveries of 39,600 AF per year, which is somewhat more than the average deliveries for the base case. The closeness of the average deliveries for Alternatives 1 and 3 indicates that the proposed fishery recovery facilities provide similar operational functionality to the existing Sunol Infiltration Galleries.

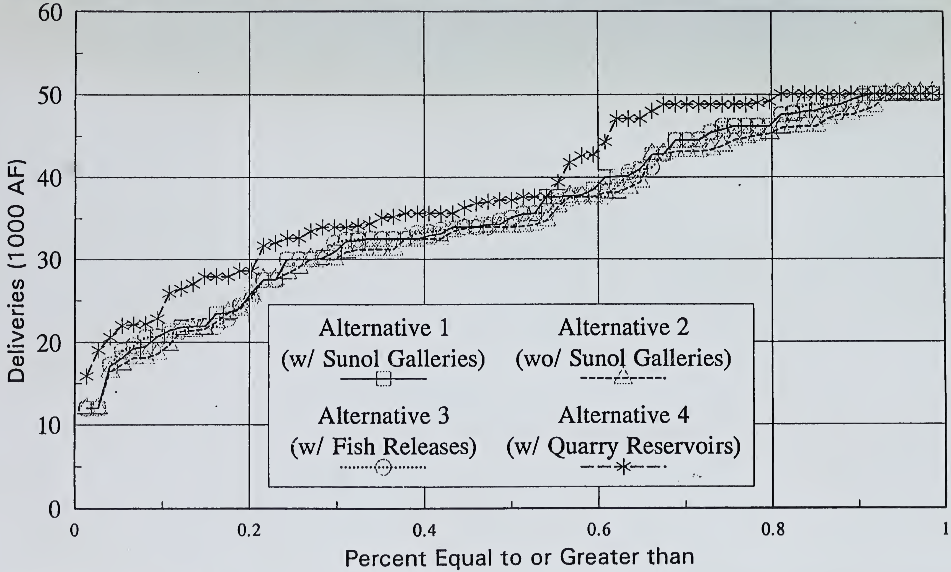
Table 5-1 ALAMEDA CREEK OPERATION MODEL 1918-1990 STUDY SIMULATION RESULTS (1,000 AF)				
Description	Alternatives			
	1 Base Case	2 No Infiltration Galleries	3 With Fish Releases	4 With Quarry Reservoirs
Average Delivery	37.7	36.5	39.6	43.3
Spills	12.9	14.2	10.6	7.0
Evaporation	7.3	7.3	7.3	8.1
Total Disposal	57.9	58.0	57.5	58.4
Minimum Delivery	12	12	12	21
Probability of 15% Shortage[1]	0.19	0.20	0.20	0.07

[1] Shortage relative to Level 3 deliveries at 30,000 AF per year.

Alternative 4, which incorporates Quarry Reservoirs in SFWD operations, results in an average of 43,300 AF per year, an annual increase of about 5,600 AF over the base case. Alternative 4 provides an especially large increase in potential SFWD deliveries during the driest quartile of years. In the lowest quartile of years, when water supplies are most valuable and surplus Hetch Hetchy supplies are not available, Alternative 4 results in an increase of 4,000 AF per year.

A comparison of the frequency of water deliveries for Alternatives 1 through 4 is shown in Figure 5-4. In this figure, the water deliveries for each alternative are ranked for the 73-year simulation period and are plotted from least to greatest. This figure also shows the close similarity in water deliveries between Alternatives 1, 2, and 3. Alternative 2, which does not include the Sunol Filter Galleries, is slightly lower than the other alternatives nearly all the time. There is virtually no difference between Alternatives 1 and 3. Alternative 4, which includes the quarry reservoirs, is consistently higher and results in an especially large increase in deliveries for amounts less than 30,000 AF.

Alternatives 3 and 4 both provided the recommended fisheries flows in the Biosystems November 1993 report without shortage. Both Alternative 3 and 4 resulted in some months when Calaveras Reservoir storage fell slightly below the recommended minimum storage amount of 30,000 AF in one or more months at the end of the study period in October 1990.



1918-1990 Study Period

ALAMEDA CREEK WATER RESOURCES STUDY

WATER SUPPLY DELIVERY FREQUENCY

SAN FRANCISCO WATER DEPARTMENT

BOOKMAN-EDMONSTON ENGINEERING, INC.

JANUARY 1995

T:/DWG/ALAMEDA/FIGTMPR 1/23/95

SECTION 6 GRAVEL EXTRACTION

22

Quarry extraction of gravel in the Sunol Valley is probably the most visible beneficial uses of SFWD property. In this section, the gravel quarry operations are reviewed to quantify their benefits and possible impacts on SFWD's primary objective of developing high quality water supplies in the Alameda Creek watershed. Additionally, several alternatives for future management of gravel quarry operations are described. A more complete description of historical and future gravel mining operations is presented in Appendix G, *Ground-Water and Aggregate Resources, Sunol Valley.*

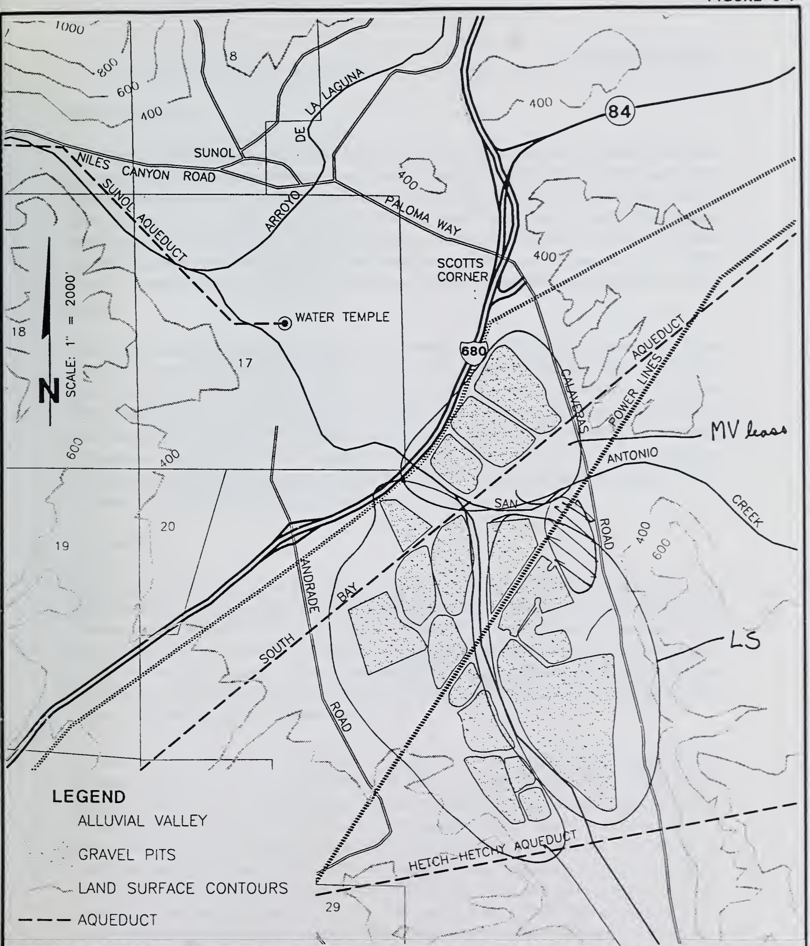
EXISTING QUARRY OPERATIONS

Gravel quarry operations have developed in Sunol Valley since the 1960s on lands leased from SFWD as well as lands owned by others. Two operators have active gravel quarries in the Valley: Mission Valley Rock (Mission Valley) and RMC Lonestar's subsidiary, Santa Clara Sand and Gravel Company. The locations of the existing quarry operations in the Sunol Valley are shown in Figure 6-1.

Mission Valley Rock

Mission Valley quarry operations were apparently initiated on non-SFWD lands located immediately west of Alameda Creek. In 1985, Mission Valley subleased approximately 135 acres of SFWD property immediately south of I-680 and east of Alameda Creek. Quarry operations in the non-SFWD area west of Alameda Creek are essentially complete, and all but two of the completed gravel quarries there have been refilled with fines (such as clays and silts) resulting from mining operations. Mission Valley's processing plant is located on the west side of Alameda Creek on a refilled gravel quarry, and other completed gravel quarries there are being used for disposal of fines from continuing operations. Currently, Mission Valley gravel quarrying activities occur on the SFWD lease on the east side of Alameda Creek.

In addition to quarrying operations on southeast side of I-680, Mission Valley also has a 70-acre lease for future mining on the northwest side of I-680. Gravel quarry operations on this 70-acre lease have not been initiated as a result of a voluntary moratorium pending resolution of valleywide gravel quarrying issues described later. Mission Valley's quarry leases provide that the completed gravel quarries will be reclaimed as specified in their Alameda County mining permits. Current plans call for future reclamation completed quarries on SFWD property for water storage.



ALAMEDA CREEK WATER RESOURCES STUDY

EXISTING GRAVEL OPERATIONS

SAN FRANCISCO WATER DEPARTMENT

MV private land

/DWG/ALAMEDA/FIG6-1 1/23/95

RMC LONESTAR

The RMC Lonestar operations, located on the east side of Alameda Creek between the Hetch Hetchy Aqueduct and San Antonio Creek, were initiated in the 1960s on lands leased from SFWD. RMC Lonestar's lease is approximately 278 acres, of which 117 have been mined. The majority of the mining has taken place in one large quarry located just to the north of the Hetch Hetchy Aqueduct in the former stream channel of Alameda Creek. The current western boundary of this quarry is the realigned channel of Alameda Creek. RMC Lonestar's plant is located on the east of its lease, between its primary quarry and Calaveras Road.

The current operations of RMC Lonestar are controlled by a sublease between Santa Clara Sand and Gravel and the City of San Francisco which expires in the year 2000. That lease was amended in 1993 to add 45 acres of quarry excavation area immediately north of the RMC Lonestar plant. Current plans call for the excavation of this supplemental 45-acre area with future use of that site for backfill with fines from gravel processing. Ultimately, reclamation plans call for RMC Lonestar to convert 92 acres of its lease to agriculture, 101 acres to future water storage, 45 acres to Alameda Creek, and approximately 40 acres to uses such as dikes and planting areas.

DISCUSSION

Based on available data, no significant adverse impacts to water resources have been identified from historic gravel quarry operations. Fines resulting from processing gravel extractions are normally managed entirely on operator's land (Mission Valley) or SFWD leased land (RMC Lonestar) and, except for infrequent incidents of reported quarry pond spills, do not affect Alameda Creek stream flows. Additionally, since the fines that are deposited in completed gravel quarries result entirely from excavations in other parts of the valley, no contamination of the aquifer occurs. *

As described in Section 4, the potential for groundwater development in Sunol Valley is minimal based on the thin depth (50 to 70 feet) of highly transmissive recent alluvial deposits and the low transmissivity in the underlying Livermore Gravel deposits. Consequently, the disruption to the Sunol Valley aquifer that results from removal of gravel deposits does not appreciably diminish water development opportunities. Conversely, the completed gravel quarries provide relatively large volumes of potential storage capacity that can increase SFWD's water development in Sunol Valley. Because of the potential for using gravel quarries as supplemental surface water reservoirs, SFWD should pursue quarry reclamation for water supply purposes rather than for agricultural purposes. Ultimate use of the reclaimed quarries for water storage could be implemented sooner through arrangements with gravel operators to accelerate completion of excavation operations and minimize expanding the overall area of quarries. The available volume of reclaimed

quarries can be increased if the fines resulting from quarry operations are minimized and deposited in abandoned quarries off SFWD leases.

QUARRY DEVELOPMENT ALTERNATIVES

Four alternatives were identified for managing future quarry development in Sunol Valley. These alternatives range from completion of existing permitted uses to aggressive development of additional gravel resources in the valley. In describing these alternatives, the assumption is made that the ultimate reclamation of the quarries will be for use as surface water reservoir storage. The four alternatives are described below and the areas that would be affected by each alternative are shown in Figure 6-2.

ALTERNATIVE 1—COMPLETE EXISTING PERMITTED MINING

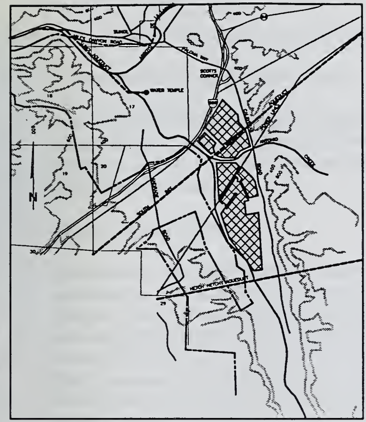
With this alternative, gravel quarrying operations would be completed on existing Mission Valley and RMC Lonestar leases from SFWD. RMC Lonestar operations would include completion of their current "Main Pit," two or three smaller excavations between the larger pits, and a recently leased 45-acre pit located adjacent to Calaveras Road which is planned for excavation and subsequent use for disposal of fines. Mission Valley's operations would include completion of the "New Lease" mining area immediately southeast of I-680, but expansion onto the 70-acre Vineyard lease area located northwest of I-680 would not be allowed by SFWD. *

ALTERNATIVE 2—EXTEND DEPTH OF EXISTING MINING

Existing mining permits call for development of gravel quarries to a depth of 140 feet. In most quarries, there is no physical basis for limiting development of the quarries to 140 feet. Deepening the existing permitted quarries would increase quarry revenues and eventual reservoir storage space without increasing the total disturbed surface area. With this alternative, the existing quarries would be deepened to a depth of 200 feet, which is the maximum feasible depth for most quarries based on surface area of the individual excavations and requirements for side slope stability. This alternative also assumes that no expansion would occur onto the currently permitted Vineyard lease northwest of I-680. *

ALTERNATIVE 3—CONSOLIDATE EXISTING MINING AREAS

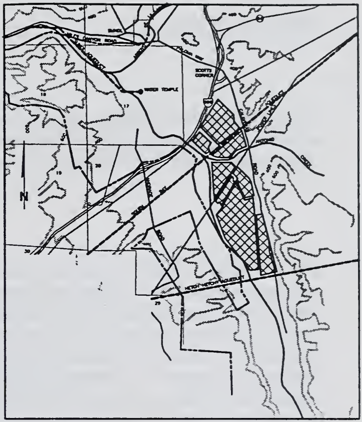
This alternative incorporates the 200-foot deepening of the existing gravel quarries with consolidation to adjacent areas that are currently unpermitted. The gravel quarries would be expanded to include existing areas of nursery leases located between Calaveras Road and the Mission Valley and RMC Lonestar gravel quarries. As with the previous alternative, gravel operations would not be expanded to the currently permitted Vineyard lease. Arrangements would be made to consolidate current mining activities in the valley to allow excavation of the area underlying the RMC Lonestar gravel processing plant area.



ALTERNATIVES 1&2

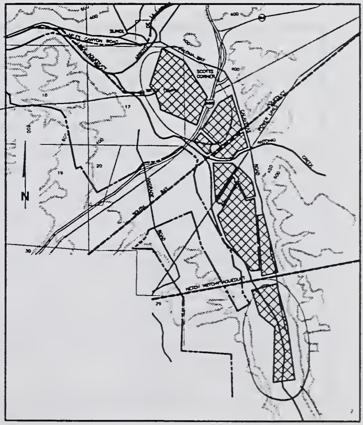
200' D

140' D



ALTERNATIVE 3

18,000



ALTERNATIVE 4

LEGEND

ALLUVIAL VALLEY

MINING AREAS

LAND SURFACE CONTOURS

SFWD PROPERTY BOUNDARY

ALAMEDA CREEK WATER RESOURCES STUDY

GRAVEL EXTRACTION DEVELOPMENT ALTERNATIVES

SUNOL VALLEY

SAN FRANCISCO WATER DEPARTMENT

11,000AF

ALTERNATIVE 4—EXPAND MINING AREAS

With this alternative, an aggressive expansion of mining activities would occur in Sunol Valley. Mission Valley operations would be expanded to include the entire area northwest of I-680 to a depth of 200 feet. Mining operations would also be expanded south of the Hetch Hetchy Aqueduct.

GRAVEL LEASE REVENUE

The benefits from each mining alternative would consist of revenue from the mining operations, as well as the reservoir storage space that would result from the completed quarries. Based on the royalty payments specified in RMC Lonestar and Mission Valley lease of $0.60 per ton of sand and gravel and the amount of excavation that has taken place, the amount of revenue received by SFWD from RMC Lonestar and Mission Valley through 1993 is estimated to be $11,600,000 and $4,800,000, respectively. A summary of projected future (post-1993) revenue, based on the royalty rates currently specified in the leases, is shown in Table 6-1, along with a summary of the storage space that would result from each alternative.

Table 6-1
QUARRY DEVELOPMENT ALTERNATIVES

Alternative	Surface Area Affected (acres)	Reservoir Storage Created (AF)	Future Mining Royalties ($1,000,000)	Visual Environmental Impacts
Alternative 1: Complete Permitted Mining 140'	289	26,880	22.6	No expansion northwest of I-680.
Alternative 2: Extend Depth of Existing Mining 200'	289	32,460	36.2	No expansion northwest of I-680.
Alternative 3: Consolidate Existing Mining Areas 200'	368	44,750	52.9	No expansion northwest of I-680; some expansion on fringes of current quarry areas southeast of I-680.
Alternative 4: Expand Gravel Mining Areas	653	79,450	109.3	Major expansion northwest of I-680; vegetation impact south of Hetch Hetchy Aqueduct.

The primary adverse impact of the mining alternatives is the disruption to lands in the Sunol Valley. Because the area located between I-680 and the Hetch Hetchy Aqueduct has already been radically altered, additional gravel development in those areas would have minimal impact. Development northwest of I-680, while providing large volumes of

supplemental surface reservoir storage space, would have significant visual impacts for I-680 traffic and visitors to Sunol Valley. Development south of the Hetch Hetchy Aqueduct would also increase the visual impacts of gravel quarry operations on Sunol Valley and would result in removal of numerous large oak and sycamore trees and affecting the riparian corridor along Alameda Creek. As described previously, the ultimate land use in SFWD watershed lands is currently being considered in the San Francisco Watershed Management Program. *

Irrespective of which alternative is selected, it is appropriate for SFWD to begin identifying a future gravel quarry configuration and directing development of the quarries to meet that configuration. For water supply purposes, it is desirable to maximize the volume of reclaimed quarries at the earliest feasible date. Consequently, historic practices for disposing of fines resulting from quarry operations should be reviewed. Where possible, consideration should be given to storing excavated fines in abandoned gravel quarries located off SFWD property. As leases are renewed, provision should be made for an ultimate quarry configuration that maximizes quarry volume, provides a physical quarry configuration that is conducive to reservoir use, and accelerates completion of quarries to allow water storage.

ALTERNATIVE USES

In addition to potential reclaimed quarry use for surface reservoirs, two other uses have been identified: seasonal recycled water storage, and disposal of sludge generated by the Sunol Treatment Plant.

Recycled Water Storage

Recycled water may be available from the Dublin San Ramon Sanitation District Wastewater Treatment Plant located north of the Sunol Valley. The recycled water is available year-round; however, many recycled water uses occur primarily during the summer and early fall irrigation season. Conceptually, one or more completed gravel quarries could be identified and reserved for winter and spring storage of recycled water. The potential quantities of recycled water have not been determined, but would likely require only a portion of the storage space that will be made available from the quarries. The need for recycled water storage may occur during the next five years, and consideration may be given to reserving a portion of the gravel quarries for recycled water storage. Since the source of recycled water is north of the Sunol Valley, it would be most convenient to designate a quarry for recycled water storage at the northern end of the valley. Practical considerations for recycled water storage in quarries are primarily related to water quality factors. Possible concerns relate to recycled water movement into adjacent groundwater, and as subsurface accretions, into Alameda Creek. Additional water quality concerns also relate to the potential subsurface flow between recycled quarries and freshwater quarries that could contaminate the freshwater quarries. Consideration of recycled water storage in quarries should address these water quality and operational concerns.

Sludge Disposal where is disp. now?

Sludge disposal in Sunol Valley reclaimed gravel quarries has also been suggested. Currently, ponds at the Sunol Treatment Plant that store the sludge remaining after water treatment are nearing capacity. The sludge they contain, which consists primarily of inert ~~alum~~, could potentially be stored in a small reclaimed quarry with a capacity of about 10 AF.

Concerns about such disposal relate primarily to water quality. Additionally, although the required quarry capacity is small, the available quarries on SFWD leases are all considerably larger in size. Because of this, a relatively large quarry with over 100 AF of capacity might need to be designated for storing only a comparatively small volume of sludge. Any consideration of quarry use for sludge disposal should consider the potential impacts on water quality and the amount of reservoir space that would be forgone. Another alternative to storage on SFWD-leased land could be blending with gravel processing "fines" and disposal in small pits west of Alameda Creek that are operated by Mission Valley. This alternative would require the approval of Mission Valley.

SECTION 7 OTHER BENEFICIAL USES

The Alameda Creek Watershed has historically supported such beneficial uses as agriculture and recreation. Since the SFWD owns the majority of the land in the study area, many of these beneficial uses take place on SFWD land and are subject to leases with the district. Currently, SFWD is supporting development of a Watershed Management Plan for the Alameda Creek Watershed, as well as the San Francisco Peninsula Watershed. Development of the Watershed Management Plan will consider both the benefits derived from current land uses in the watersheds and their compatibility with the SFWD's primary mission of supplying high quality water to its customers. The completed Watershed Management Plan will include recommendations for beneficial uses that will not necessarily be the same as those currently existing.

The discussion of beneficial uses here considers only current uses in the watershed. No recommendations are made regarding whether these uses should continue. Rather, a brief description of the current status of existing and potential beneficial uses is presented, followed by a review of positive and negative impacts on SFWD water supplies.

AGRICULTURE

Agriculture has historically been the primary land use in SFWD's Alameda Creek Watershed. Initially, the primary agricultural uses were irrigated cropland in the Sunol Valley and cattle grazing in upland portions of the watershed. Currently, irrigated crops in the Sunol Valley have been replaced to a large extent by gravel quarrying operations and nurseries. Cattle grazing, however, continues to be a major land use in the watershed.

In the Sunol Valley, the lands around the Water Temple have been cultivated since their purchase by the SVWC in the 1800s. Currently, 118 acres of grain and two acres of persimmons are grown in the Sunol Valley near the Water Temple. The consumptive use of applied water from these crops is estimated to be 4 AF per year.

In addition to irrigated cropland, the SFWD has three nursery leases in the lower Sunol Valley. Some of the nursery lessees sublease portions of their leased area; and there are currently a total of eight nursery operators on SFWD lands in lower Sunol Valley. The total nursery production area is approximately 200 acres. As part of this study, Ogden Environmental and Energy Services Company conducted a survey of nursery operators. The complete results of this survey are summarized in Appendix D, *Alameda Creek Revegetation/ Restoration Report*. Based on surveys sent to these lessees, water supply for the nurseries is currently derived entirely from SFWD water supply lines. Based on the completed surveys from six of the eight operators, 68 percent of the nursery lands are irrigated with drip irrigation. The remaining 32 percent was irrigated primarily by sprinkler irrigation and hand watering. Based on average evapotranspiration rate of approximately 50 inches, the

SECTION 8 FACILITIES EVALUATION

Implementation of the potential fisheries management programs or quarry reservoirs described in previous sections of this report will require additional facilities. Potentially, the facilities required to recover planned fisheries releases could include use of the existing Sunol Infiltration Galleries or development of new recapture facilities. Several options which were identified for recovering planned fisheries releases are summarized in this section and described in greater detail in Appendix H, *Report on Water Recovery Facilities.*

In addition to the proposed fishery flow recovery facilities, additional facilities will also be required for operation of the proposed quarry reservoirs. In theory, the quarry reservoir facilities would also be able to recapture fisheries flows. However, the quarries are currently being mined and will probably not be available for development to reservoir storage purposes for twenty years or more. Because of this delay, the reclaimed quarries will not be available for fishery flow recovery in the near future and are not considered as a recovery option. Additionally, uncertainties about the extent and depth of future quarry excavations mean that a detailed layout and cost estimate for the quarry reservoirs is premature at present. However, a conceptual layout for the quarry reservoirs is presented later in this section that provides a general indication of facility costs.

RECOVERY FACILITIES

Several alternatives were identified that could be implemented to recover Calaveras Reservoir flow releases. The following section begins by summarizing the requirements for recovery facilities, which affect the design of the facilities. Three alternatives are then described that would meet the recovery requirements. Conceptual designs and costs are provided, and an alternative is recommended.

Facility Requirements

As described in Section 3, fisheries flows from Calaveras Reservoir are being considered for enhancing fishery habitat in Calaveras and Alameda Creeks. The proposed flows vary from 20 cfs in February and March to 5 cfs during November through January. The proposed recovery facilities require sufficient capacity to recover the higher potential flow amounts. In addition to fishery recovery needs, Section 5 identified the desirability for enhanced flow capture capability of 50 cfs to replicate Sunol Infiltration Galleries capacity and increase the potential use of high flows on Alameda Creek.

Flows recovered at the proposed facilities should be available for delivery to two locations—San Antonio Reservoir and the Sunol Treatment Plant. Under normal operating conditions, flows would be recaptured and directly supplied to the Sunol Treatment Plant. Occasionally, however, operational factors will indicate a preference for pumping to San

Antonio Reservoir for storage. In addition to San Antonio Reservoir and the Sunol Treatment Plant, the recovery facilities should also be capable of future delivery to the quarry reservoirs for storage.

In designing facilities that can deliver recovered water to either San Antonio Reservoir or the Sunol Treatment Plant, consideration needs to be given to integrating recapture facility with existing facilities. Delivery to either San Antonio Reservoir or the Sunol Treatment Plant can be complicated by Hetch Hetchy operations which can result in Hetch Hetchy deliveries to either facility. An additional complication is the operation of San Antonio Reservoir, which can itself deliver water to the Sunol Treatment Plant at the same time as flow recovery is occurring. The proposed recapture facilities must be operational under any conceivable combination of preexisting operations involving San Antonio Reservoir, the Sunol Treatment Plant, or the Hetch Hetchy Aqueduct.

A further design requirement relates to the overall effectiveness of facility operation. To maximize their effectiveness, the flow recapture facilities should minimize the potential for losses to subsurface seepage, evapotranspiration, and surface flow. Specific elements of the recapture facilities should address the prevention of each of these types of losses. To be effective, the recapture facilities must prevent inflow of either surface or groundwater to the existing gravel quarries. This can be accomplished by sealing the quarries from groundwater flow with subsurface cutoff walls, by locating the recapture facilities at the upper end of Sunol Valley where both surface and subsurface flows are confined (near the Sunol Treatment Plant), or by a combination of the two approaches.

Finally, the selected alternative should consider the potential for hydrocarbon spills from the existing Chevron Pipeline located in upper Sunol Valley. The Chevron Pipeline is located on the east side of Sunol Valley from near San Antonio Creek to just downstream of the Sunol Treatment Plant, where it turns west and crosses Sunol Valley. Earthquakes on the Calaveras Fault (located on the east side of Sunol Valley), the Sinbad Fault (located on the western edge of Sunol Valley), or other major faults in the area could cause pipeline breakages and leaks that could affect proposed recapture facilities. Although locating the recapture facilities upstream of the pipeline would minimize potential contamination of recapture facilities from potential pipeline spills, a downstream location that includes subsurface cutoff walls could contain potential spills. At this stage of analysis, it is not clear which location (upstream or downstream of the Chevron Pipeline) is preferable, and future studies will need to address this issue.

Facility Alternative Analysis

Three potential flow recapture alternatives were identified for analysis:

- Recovery of subsurface flows at the downstream (west) end of the Sunol Valley utilizing rehabilitated Sunol Infiltration Galleries.

- Recovery of subsurface flows on the floor of the Sunol Valley utilizing a subsurface cutoff wall near the Hetch Hetchy Aqueduct in conjunction with either a dense, shallow well field or an infiltration gallery.

- Recovery of surface and subsurface flows near the filtration plant utilizing an inflatable rubber dam with a subsurface cutoff wall in conjunction with either a streamside intake structure or an infiltration gallery.

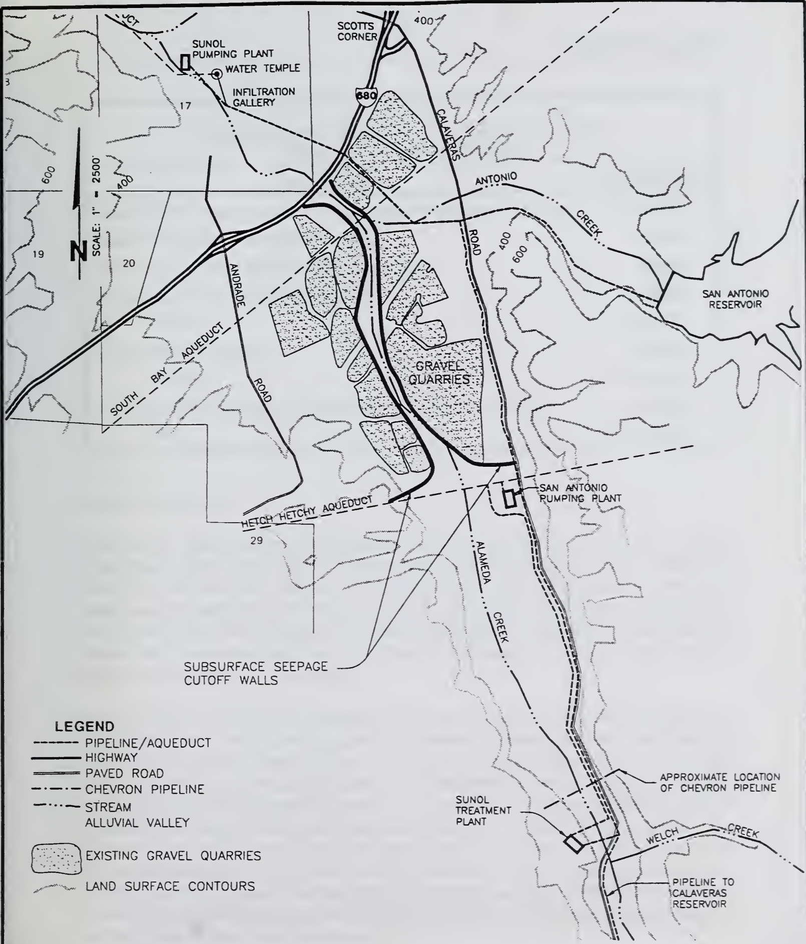
The principal elements of each of these alternatives are described individually below, along with estimates of the capital costs for their development. In addition to facilities unique to each of the recapture alternatives, the proposed fisheries releases will require a modification to Calaveras Reservoir facilities. At Calaveras Reservoir, use of the 72-inch cone valve on a continuous basis could result in degradation of the valve over time. An alternative to using the cone valve would be to install a sleeve valve in the 72-inch Calaveras Pipeline at the base of Calaveras Dam. Installation of this sleeve valve and required ancillary facilities (including a flowmeter) is estimated to cost $170,000. The sleeve valve and related facilities would be required for each of the alternatives identified above, and its cost is included in the alternative cost estimates.

Rehabilitation of the Sunol Infiltration Gallery

The Sunol Infiltration Gallery could be rehabilitated to recapture the fish releases as subsurface flow at the downstream end of the Sunol Valley. Recovery of surface flows would require diverting water from Alameda Creek utilizing a temporary gravel dam constructed in the streambed as has been done historically. Flows recaptured at the infiltration gallery would be pumped by the Sunol Pumping Plant to either the San Antonio Reservoir or the Sunol Treatment Plant.

Development of gravel quarries in the Sunol Valley and the subsequent partial dewatering of the shallow groundwater aquifer has apparently reduced the yield of the infiltration gallery. If the infiltration gallery is to serve as an effective recapture facility, extensive subsurface cutoff walls must be constructed through the Sunol Valley, as shown in Figure 8-1, to prevent seepage into the gravel quarries. These cutoff walls would extend to depths between 50 and 100 feet to reach the relatively impermeable Livermore Gravel Formation underlying the shallow alluvium on the Sunol Valley floor.

The infiltration gallery is currently in a state of disrepair; thus utilization of the Sunol Infiltration Gallery to recapture the flow releases would require rehabilitation of the existing 2,000-foot gallery. A reconnaissance-level investigation suggests that about 1,000 feet of the infiltration gallery is salvageable, while the remaining 1,000 feet must be removed and replaced. The existing Sunol Pumping Plant would be utilized to pump the recaptured flows either to San Antonio Reservoir or the Sunol Treatment Plant. Table 8-1 presents an estimate of the costs associated with rehabilitating the Sunol Infiltration Gallery.



ALAMEDA CREEK WATER RESOURCES STUDY

RECAPTURE ALTERNATIVE
REHABILITATION OF SUNOL INFILTRATION GALLERY

SAN FRANCISCO WATER DEPARTMENT

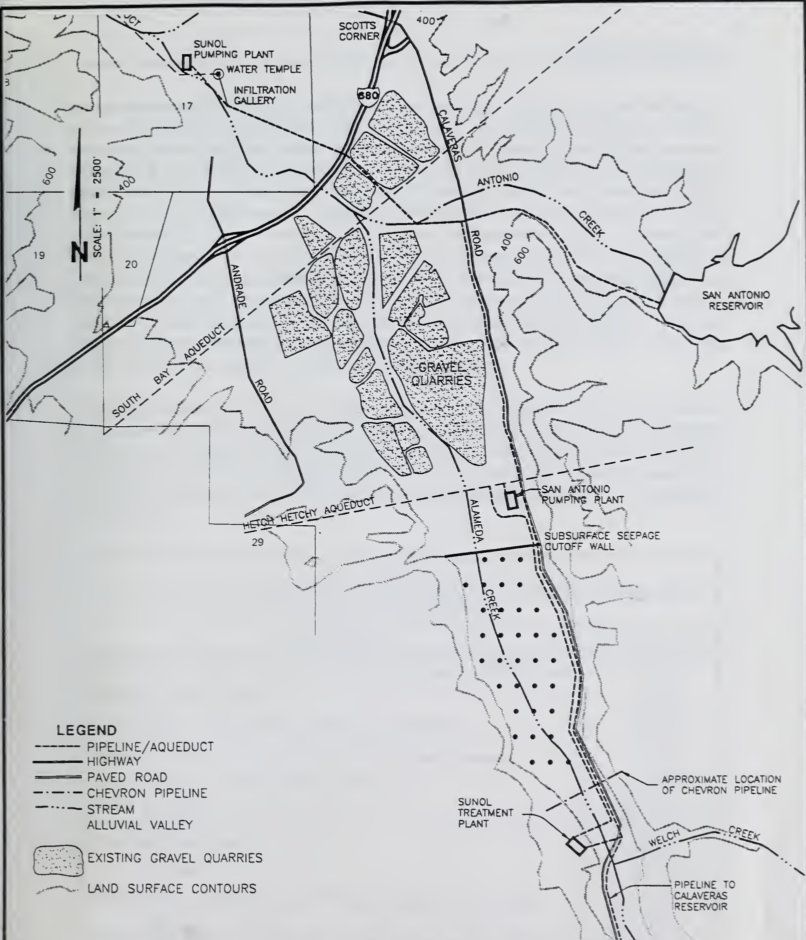
Table 8-1
REHABILITATION OF SUNOL INFILTRATION GALLERY
ESTIMATE OF CAPITAL COSTS

Item Description	Estimated Cost
Cutoff Wall–3.1 miles in length to an assumed average depth of 75 feet	$10,300,000
Rehabilitate 1,000 feet of infiltration gallery	300,000
Remove and replace 1,000 feet of infiltration gallery	550,000
Calaveras Reservoir release modifications	170,000
Subtotal:	$11,320,000
Contingency at 25 percent	2,830,000
Subtotal:	$14,150,000
Engineering, administration, and construction support at 15 percent	2,120,000
Total:	$16,270,000

Subsurface Recovery

Based on the groundwater investigations summarized in Section 4, the Sunol Valley groundwater basin is not capable of supporting a conjunctive use program. Substantial quantities of shallow alluvium have been removed from the central portion of the Sunol Valley, and the underlying Livermore Gravels has inadequate well yields. Although the Sunol Valley Basin can not support conjunctive use of surface water and groundwater, the shallow alluvium at the upper end of the basin is sufficient for recovery of the relatively small amounts of fishery flow releases.

A dense, shallow well field was considered that would include a downstream subsurface cutoff wall near the Hetch Hetchy Aqueduct to minimize groundwater flow away from the well field. A schematic drawing of such a well field is shown in Figure 8-2. The well field itself would include a system of shallow wells completed to depths of 55 to 60 feet that primarily extract from the shallow alluvium. A network of collection pipelines would be constructed to deliver water from individual wells to a central pumping plant. The pumping plant would have sufficient capacity and horsepower to deliver recaptured groundwater through a new pipeline to existing facilities for ultimate delivery to either San Antonio Reservoir or Sunol Treatment Plant. Preliminary analysis of the shallow well field options indicates that the arrangement is not practical due to the limited available area and resulting, unacceptably high drawdowns.



ALAMEDA CREEK WATER RESOURCES STUDY

RECAPTURE ALTERNATIVE
DENSE, SHALLOW WELL FIELD

SAN FRANCISCO WATER DEPARTMENT

As an alternative to the shallow well field, subsurface flows could be recovered utilizing an infiltration gallery near the Hetch Hetchy Aqueduct. As with the shallow well field, a subsurface cutoff wall that extends downward to the Livermore Gravel formation would minimize downstream groundwater flows that could not be recaptured. The infiltration gallery would be a modern design using buried perforated pipe that is arranged radially from a central pumping sump. A multibay pumping plant would be located at the sump with a battery of pumps. A potential pumping plant arrangement would be to provide four pumps with capacities of 5, 10, 15, and 20 cfs, which would provide the flexibility to recapture flows for the entire range of potential release amounts. As with the shallow well field approach, the infiltration gallery would require new conveyance facilities to deliver water to existing facilities for ultimate delivery to San Antonio Reservoir or the Sunol Treatment Plant. Table 8-2 presents an estimate of the costs of constructing a subsurface cutoff wall and flow recapture with an infiltration gallery.

A potential disadvantage of the subsurface recapture option is that it is located downstream of the Chevron Pipeline and would be subject to contamination in the event of a pipeline rupture. Such a pipeline rupture would probably result in a recapture facilities outage for an extended period. The subsurface cutoff wall would minimize downstream seepage of spill contamination and would concentrate the cleanup area, possibly improving long-term spill cleanup.

Table 8-2
SUBSURFACE RECAPTURE WITH CUTOFF WALL AND INFILTRATION GALLERY
ESTIMATE OF CAPITAL COSTS

Item Description	Estimated Cost
Cutoff Wall–2,200 feet in length to an assumed average depth of 60 feet	$ 980,000
Infiltration gallery–3,000 feet	1,280,000
Pumping plant with reinforced concrete sump (2,400 hp)	1,800,000
Pipeline–1,000 feet of 42-inch-diameter RCP with appurtenances	160,000
Calaveras Reservoir release facility modifications	160,000
Subtotal:	$ 4,390,000
Contingency at 25 percent	1,100,000
Subtotal:	$ 5,490,000
Engineering, administration, and construction support at 15 percent	1,370,000
Total:	$ 6,860,000

Surface Impoundment

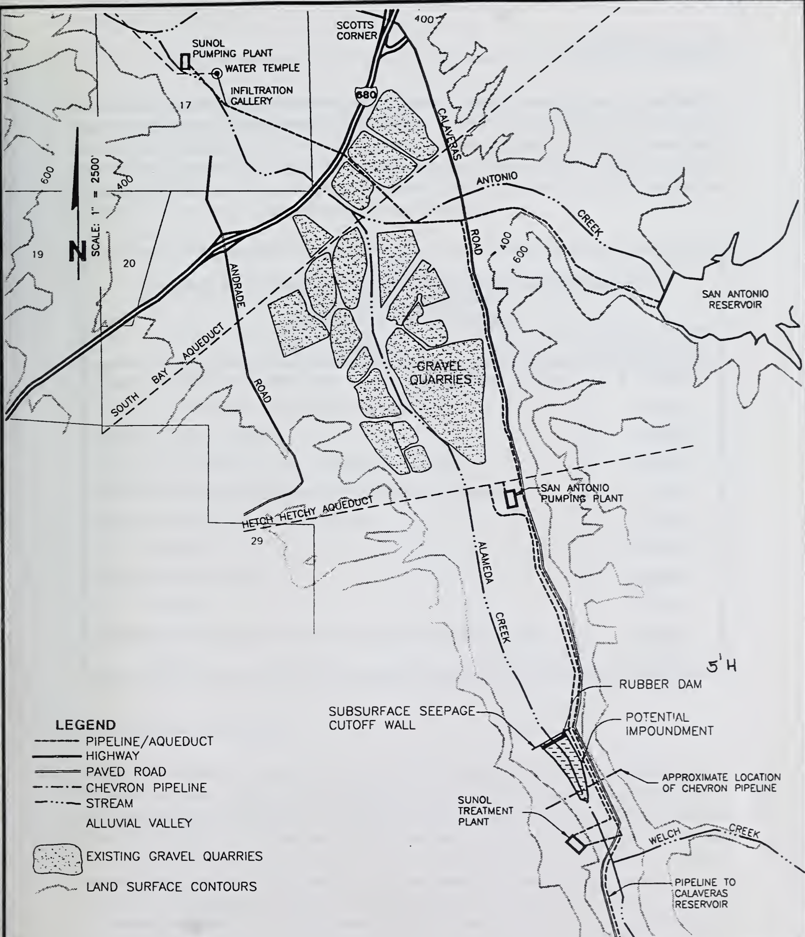
Relying solely on subsurface recapture of the fishery flow releases would have one serious drawback: specifically, surface flows that did not fully infiltrate the Alameda Creek streambed upstream of the subsurface cutoff wall and infiltration galley would not be recaptured. An alternative to subsurface flow recapture is surface impoundment.

Surface impoundment permits locating the recapture facilities farther up the valley, closer to the Sunol Treatment Plant, as shown on Figure 8-3. Two principal advantages result: the recapture facilities are closer to the treatment plant which reduces pumping costs; and, because the valley is narrower, the flows are constrained, which improves the potential efficiency of the recapture facilities.

The selected impoundment site is located slightly downstream of the Chevron Pipeline, which is considered to be the preferred site based on access considerations. The impoundment site could also be relocated upstream to a site above the Chevron Pipeline, if potential concerns about spills are significant. Although access at the upstream location is somewhat more restricted than the selected site, no significant cost increase is expected. The alternative upstream impoundment locations, while minimizing contamination of recapture facilities during a pipeline spill, would not contain pipeline spill migration downstream.

As shown in Figure 8-3, a general location for a surface impoundment was selected that is about 1,500 feet downstream of Sunol Treatment Plant. A 400-foot concrete dam of about five feet in height with a 100- to 250-foot inflatable rubber dam section would be constructed at the site. The rubber dam would be inflated to create a small reservoir for capturing fisheries flows. The rubber dam could be deflated to allow free passage of flood flows without overtopping the facility. A subsurface cutoff wall would be constructed beneath the dam to minimize groundwater movement downstream of the recapture facilities. When full, the dam would create a reservoir with an area of seven acres and a capacity of 30 AF.

As with the subsurface recapture option, a sump would be included with a battery of pumps that provides flexibility for matching fishery release rates. Flows recaptured at the reservoir could be pumped to either San Antonio Reservoir or the Sunol Treatment Plant. Flows would be recaptured and diverted to the pumping plant sump utilizing either a streamside intake structure situated on the bank of Alameda Creek adjacent to the reservoir created by the rubber dam, or a bed-mounted infiltration gallery underlying the reservoir. The disadvantage of the streamside intake structure is that only surface flows could be recaptured, and it is possible that low flows could percolate to the groundwater prior to reaching the dam. A subsurface infiltration gallery would provide the capability for recapturing low flows, but its effectiveness could be impaired by reduced vertical



ALAMEDA CREEK WATER RESOURCES STUDY

RECAPTURE ALTERNATIVE
RUBBER DAM WITH SURFACE IMPOUNDMENT

SAN FRANCISCO WATER DEPARTMENT

permeability resulting from reservoir sedimentation. Further investigations are required to identify the relative effectiveness of each alternative. However, for costs analysis purposes, the infiltration gallery approach was used, since it is a more conservative (i.e., more costly) approach and provides the capability for recovering subsurface flows. Table 8-3 presents an estimate of the costs of recapturing flows near the filtration plant utilizing a rubber dam to impound water over a bed-mounted infiltration gallery.

Table 8-3
SURFACE AND SUBSURFACE RECAPTURE WITH RUBBER DAM AND INFILTRATION GALLERY
ESTIMATE OF CAPITAL COSTS

Item Description	Estimated Cost
Cutoff Wall–1,000 feet in length to an assumed average depth of 50 feet	$ 330,000
Concrete weir–450 feet wide with 200-foot rubber dam	1,500,000
Infiltration gallery–1,000 feet	420,000
Pumping plant with reinforced concrete sump (2,400 hp)	1,800,000
Pipeline–500 feet of 42-inch-diameter RCP with appurtenances	80,000
Calaveras Reservoir release modifications	170,000
Subtotal:	$ 4,300,000
Contingency at 25 percent	1,080,000
Subtotal:	$ 5,380,000
Engineering, administration, and construction support at 15 percent	810,000
Total:	$ 6,190,000

Recommended Alternative

Based on the analysis described above, the most cost-effective facilities for recapturing the fisheries flows are a surface impoundment below the Sunol Treatment Plant with either a subsurface infiltration gallery or a streamside intake. In addition to the recovery facilities, a new sleeve valve is also required at Calaveras Dam. Based on a 20-year analysis period and a 7 percent interest rate, the annual costs of the proposed alternative are $584,300. A reconnaissance estimate of the energy costs associated with the fishery releases was also prepared. This estimate is based on the proposed flow requirements in Section 3 of 30 cfs in February and March, 7 cfs from June through October, and 5 cfs in the remainder of the year. Based on 8 cents per kilowatt-hour energy costs and a 190-foot head for recapturing flows at the proposed surface impoundment and delivery to the Sunol Treatment Plant, the annual pumping costs are $138,400. Actual energy costs for operation would be higher since flows would occasionally be delivered to San Antonio Reservoir, which requires more

[illegible]

[illegible]

[illegible]	[illegible]

[illegible]

[illegible]

energy. Total annual costs would be $722,800. This annual cost does not include the additional costs for operational staff and does not provide for costs, such as monitoring and reporting, for the fishery releases.

QUARRY RESERVOIRS

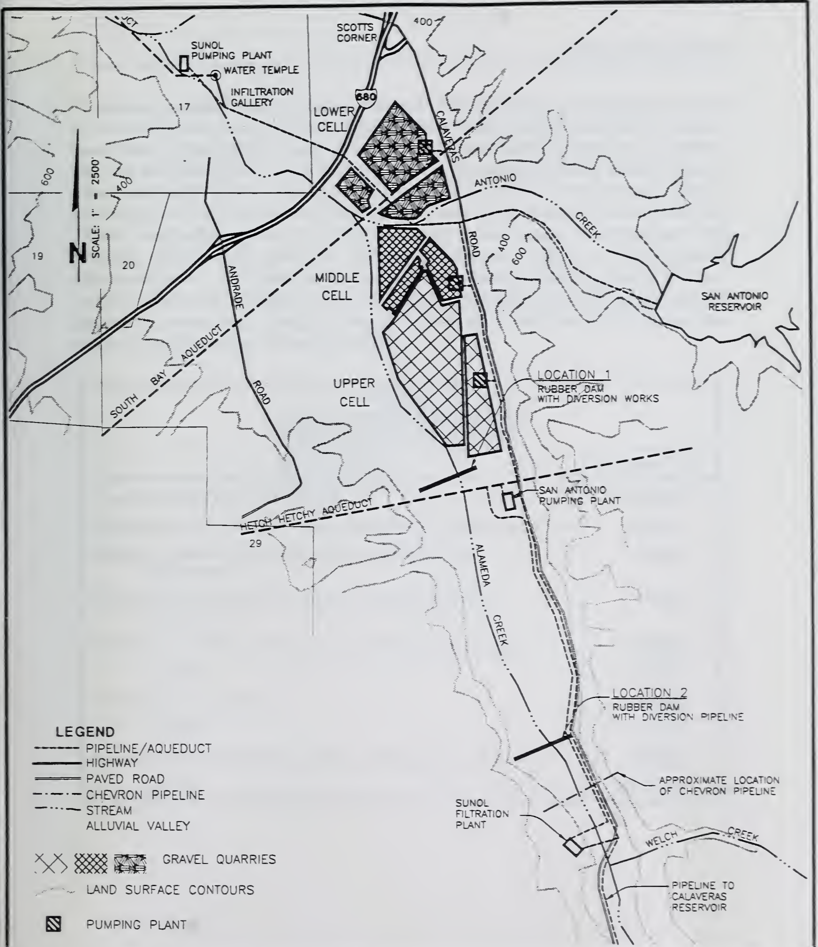
The potential for use of quarry reservoirs to provide supplemental storage in Alameda Creek was identified in Sections 5 and 6 of this report. The potential for quarry reservoir use requires completion of current gravel excavation activities in the quarries which is not expected for twenty or more years. Because of the extended period until quarries become available for storage purposes and uncertainty about the ultimate configuration of the quarries, it is not possible to develop detailed cost estimates for converting the quarries to reservoir use. However, to provide an approximate indication of the cost of quarry conversion, the configuration for Alternative 3 in Figure 6-2 has been used.

As shown on Figure 8-4, three quarry groupings were identified that could be operated as individual reservoir cells. The highest elevation quarry cell is the expanded Lonestar pit located just north of Hetch Hetchy Reservoir. A middle quarry cell would be located between the expanded Lonestar quarry and San Antonio Creek. A low elevation cell would consist of the remaining quarries located north of San Antonio Creek. The surface elevation of the quarry cells would vary from above 270 feet at the upper end of the high elevation cell to about 248 feet at the northern edge of the low elevation cell at I-680. The cells are all assumed to have depths of 200 feet, except where side slope considerations result in shallower quarries.

Cuts would be made in any intermediate sediment walls separating individual quarries that remain after quarrying activities are complete, allowing free flow between individual quarries within a cell. Cutoff slurry walls would be constructed around the perimeter of identified cells to maintain control of water within a cell. The cutoff walls would separate the individual quarry cells from each other and from the main part of the Sunol Valley groundwater basin. In total, 19,000 feet of cutoff walls would be constructed to an assumed depth of 60 feet, which would effectively seal the permeable shallow alluvium.

The upper quarry cells would be filled through a pipeline or canal from the surface impoundment near the Sunol Treatment Plant. The pipeline or canal would have a capacity of about 167 cfs. For cost estimation purposes, a 60-inch pipeline was assumed that would be 7,000 feet long. Diversions into the upper quarry cell in excess of that cell's capacity would be diverted successively into the middle and lower quarry cells. Intercell flow control structures would be required to control the elevations of each cell and regulate spills from one cell to another. Two separate sections of 60-inch pipeline, totalling 2,500 feet, were assumed to provide the intercell conveyance capability.

FIGURE 8-4



ALAMEDA CREEK WATER RESOURCES STUDY

GRAVEL QUARRIES AS STORAGE RESERVOIRS

SAN FRANCISCO WATER DEPARTMENT

To provide operational control of water storage in the quarry cells, a pumping plant would be installed in each quarry cell, and a pipeline would be constructed on the eastern edge of Sunol Valley. This pipeline would connect the individual pumping plants in each quarry cell with the existing San Antonio Pumping Plant. The pumping plants would consist of a battery of individual pumps to provide operational flexibility for extracting at different flow rates. Total capacity at each pumping plant would be 30 cfs and the assumed head of 300 feet would allow delivery to the suction side of the San Antonio Pumping Plant. The pumping plants would have an installed horsepower capacity of approximately 1,500 horsepower. In addition to delivery to the San Antonio Pumping Plant, the quarry pumping plants and collection pipeline would allow extraction from one quarry cell and delivery to another cell. Table 8-4 presents a summary of the costs for developing the reclaimed gravel quarries for reservoir usage.

Table 8-4
QUARRY RESERVOIR FACILITIES
ESTIMATE OF CAPITAL COSTS

Item Description	Estimated Cost
Pumping plant (3 with 1,500 hp each)	$3,380,000
Intake pipeline–7,000 feet of 60-inch-diameter RCP with appurtenances	1,260,000
Collection pipeline–9,000 feet of 36-inch-diameter RCP with appurtenances	970,000
Interquarry controls–2,500 feet of 60-inch diameter RCP with appurtenances	450,000
Cutoff walls–18,400 feet in length to an assumed depth of 60 feet	8,170,000
Subtotal:	$14,230,000
Contingency at 25 percent	3,560,000
Subtotal:	$17,790,000
Engineering, administration, and construction support at 15 percent	2,670,000
Total:	$20,460,000